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RENTING MOTORS.

A question which is being discussed just now in England is whether it is advisable for power companies to rent motors to their customers. There is a good deal to be said on both sides. The business of the power company is to make as much profit out of its product as it can, and this is best accomplished by securing a good steady load, which, in turn, is best secured by having a large number of customers, working under all sorts of conditions. But many who desire to become customers are prevented by the cost of installing a motor. Those who take one side of the question say that it pays the company to purchase and install a motor for this class of custom, as a profitable rent can be secured from it or the motor can be sold on instalments, with good returns. Once the motor is paid for, the custom of that particular shop is fairly secure. On the other hand, considerable capital must be available if all who desire to use the motor drive are to be supplied with a motor at the expense of the power company. Usually such companies—in this country, at least—have other uses for the money which they have or can borrow. It is a question which can not be answered in one way for all cases, and it will probably soon work out its own solution. Several years ago, in this country, we were debating whether it was advisable for lighting companies to furnish free lamp renewals, but now one seldom hears that question raised.

CONDUCTIVITY OF THE ATMOSPHERE AT HIGH VOLTAGES.

The paper read by Professor Harris J. Ryan at the meeting of the American Institute of Electrical Engineers last week forms a most important contribution to the knowledge of atmospheric conduction. Previous investigations along this line have been made by others and with valuable returns, but in all cases working under disadvantages and under conditions not entirely to be controlled by the observer. Professor Ryan's work, made in a well equipped laboratory, was unhampered by the unfavorable circumstances with which others have had to contend; and due to this condition, although more particularly to the ability of Professor Ryan himself, he has given us the most complete data that have yet been obtained on atmospheric conduction. It serves as an excellent example of the good work which can be carried out in the laboratories of our technical schools when proper facilities are furnished. It is also a noteworthy instance in which the work of the technical schools is ahead of that of the practising engineers. Conditions limiting practice are usually determined by practice, and not as here, in the laboratory, before practice has reached the limits.

Practical Bearing of Professor Ryan's Work.

While Professor Ryan's work is of great scientific value, it is probable that at this time it will attract more general attention because of possibilities and limitations of high-tension transmission which are indicated. Were it not for insulator troubles facing us to-day we might expect in the near future to see transmission systems undertaken at voltages of 100,000 or even higher, an increase which would, of course, considerably lengthen the distance of commercial transmission.

Conditions Governing Atmospheric Conductivity.

The formula deduced by Professor Ryan gives the value of the electromotive force at which the corona discharge appears surrounding the wire; that is to say, the voltage at which atmospheric losses begin to be of consequence. It takes into consideration the barometric pressure and the temperature of the air, and the size and spacing of the conductors. It is thus practically complete except that there is no term providing for the variation in the forces encountered at the surface of the electrodes, due to the electrode material. (Moisture seems to have little or no effect upon the phenomenon.) These, as is well

known, are of much importance in vacuum tube conduction, but it is possible that under the conditions of Professor Ryan's work they would be so small compared with the effect of the resistance of the air itself as to be entirely masked.

The general equation deduced by Professor Ryan explains in exact terms the effect of the various physical conditions upon the voltage at which the corona appears. Thus the allowable voltage of transmission varies, as is well known, directly with the spacing of the wires, and inversely as the diameter of the wires. It also varies directly with the barometric pressure and inversely as the temperature. This shows that for long-distance transmission, where high voltages are necessary, the wires must be spaced far apart and must be comparatively large in diameter. These conditions call for an expensive line and one, therefore, which is only practicable where large powers are to be transmitted. The formula shows also that a higher voltage is allowable at sea level than in high altitudes and in the winter than in summer. The extreme range of temperature in our latitudes might be about thirty per cent of the absolute, and the barometric variation would hardly be as much. Engineers are not going to work close up to the limit, but will reserve a considerable factor of safety, and a possibility of difference in practice between summer and winter or between mountain and sea-level line is indicated.

Cathode-Ray Indicator Used.

It is only due to Professor Ryan to point out that in this work the cathode ray indicator described by him last summer at the annual convention of the American Institute of Electrical Engineers was used with most excellent results. The value of this instrument was pointed out at that time, and it is pleasing to note that its inventor has already put it to such good use.

FAINTLY LUMINOUS BODIES AFFECTED BY A NON-UNIFORM MAGNETIC FIELD.

In a note read before the French Academy of Sciences, M. C. Gutton describes an extremely interesting phenomenon observed by himself. This is, that a non-uniform magnetic field acts on faintly luminous bodies in a manner very similar to the N-rays discovered by Blondlot. M. Gutton has found that if a piece of cardboard containing patches of phosphorescent sulphide is shifted along a magnet bar, the patches near the poles are brighter than those near the centre of the magnet. By means of suitable screens he eliminated any error due to N-rays, without appreciably affecting the result. No effect is noticeable when the screen is placed in a strong or a uniform field. It seems only to be produced where the lines of magnetic force are not parallel. The screen is very sensitive, as the effect is observed by the modification of the earth's field, caused by placing a bar of bismuth or a wire carrying a very small current a short distance away from the screen. No explanation is offered, but it is evident that if there is an increase in the luminous energy radiated, it must be either at the expense of the magnet or of the luminous screen. It is possible that an instrument based upon this action might be useful in the study of magnetic fields.

THE FLAMING ARC LAMP.

One hears little to-day of attempts to improve the arc lamp by increasing its luminous efficiency, although it has been known for some time that the addition of certain materials to the carbon electrodes added considerably to the light-giving power of these, the best known attempt to accomplish this being probably the lamp invented by Hugo Bremer.

Difficulties Met if Materials Be Added to the Carbon.

It is not an easy matter to mix with the carbon of the electrodes the material which is to increase the efficiency of the lamp, in such a way as not to produce disadvantages which more than counter-balance the gain. In the open arc lamp the light comes principally from incandescent carbon, and the vaporous arc itself gives out comparatively little light. By adding to the carbon materials such as magnesium or calcium, the arc becomes intensely brilliant. But if the light is to be steady this material should be distributed uniformly throughout the electrode, a necessity which caused the failure of a number of investigators who preceded Bremer. It is essential that the materials be thoroughly calcined before being mixed with the carbon, and it is also necessary to add to the mixture a flux which will prevent the formation of scoria on the ends of the carbon electrodes, which, being a poor conductor, would eventually extinguish the lamp. Adding the flux causes the scoria to melt at the temperature of the arc, but it then drips down on the lower carbon, and to ensure its removal from this point, Bremer coated his lower carbon with a glassy flux. This latter difficulty may be avoided in the type of lamp where the arc is projected horizontally between two inclined electrodes; but, in any case, there is a certain amount of hot, vitreous material dripping from the lamp, and it is also probable that any shades or surfaces near the lamp will become coated with dust, due to volatilization of materials in the carbon.

Improvement in Arc Lamps Desirable.

The light from the Bremer lamp may be made more agreeable than that from the open arc, and, no doubt, the luminous efficiency is greater; but these points alone are not sufficient to guarantee the success of the lamp. The success of the enclosed arc lamp was due more to its requiring less attention than the open arc than to anything else. From what we can learn, the Bremer lamp, in its present state, does not possess this advantage over the open arc. Others are also working on the problem, and we are promised other lamps of the same type, but free from some of the objections of the Bremer lamp. It is to be hoped that something definite will result from this work before long, as any practical improvement in the lamp would be of great benefit.

COMPLEXITIES OF THE CENTRAL STATION.

Although the tendency in the design of individual machines seems to be toward simpler and more primitive forms, the equipment of that combination designed for a definite purpose, and known as a generating station, is becoming more and more complex. In the early days the generating station consisted of a steam boiler, an engine belted to the dynamo, and a few

switches enabling the generator to be disconnected from the conducting system. To meet the requirements of the underwriters, it was usual to erect a brick wall between the engine room and the boiler room, but, except for this, the station building had practically but one room. To-day the bigness of the power station, and the fact that so many people are dependent upon it, make it absolutely essential that every possible precaution against interruption should be taken, and safety devices of various descriptions are necessarily employed. In addition, the size of the station makes it possible to adopt refinements, with a view to effecting economy in operation, the expense of which a smaller station could not stand; but these refinements are always at the expense of increased complication.

How far this increase in complexity will go can not be determined. As long as economy results, without too much risk of breakdowns, we may expect no change in method; but it is a question how soon this limit will be reached. In a large central station to-day one finds almost every type of electrical appliance installed, often in duplicate in case of emergency. Will not the tendency in the future follow that of machine design and be toward greater simplicity? By means of our elaborate installations we have learned how to effect economies, and it is very desirable that our fuller knowledge should enable us to obtain the same results in a simpler way.

THE EFFICIENCY OF THE OSMIUM LAMP.

Some time since reference was made to the high luminous efficiency of the osmium lamp. Since then further tests have been made, the results of which are given by Mr. F. G. Bailey in the London *Electrician*, February 12. Unfortunately, these tests were limited to but a few lamps and can not, therefore, be considered general, except in so far as they agree with previous work. Mr. Bailey finds that at the normal voltage the average efficiency of his lamps, of which there were but five, was 1.9 watts per candle. From previous work of Dr. Wedding he believes that the lamps would have an average life of about 1,900 hours, during which time the candle-power would fall to about eighty per cent of the initial value, this being the usual rating for incandescent lamps. During this time the average efficiency would be 2.1 watts per candle, or, as he puts it, at least twice the efficiency of an incandescent lamp. If these figures represent results which can be obtained commercially, and the lamps can be put out in commercial quantities, the osmium lamp will surely become a serious competitor of the carbon incandescent lamp.

Cause of Efficiency of Osmium Lamp.

There is still doubt as to the cause of the higher efficiency of this lamp, some attributing it to a higher temperature of operation, while another investigator is convinced that the temperature of the osmium lamp is considerably less than that of the carbon lamp. All, however, seem to agree that osmium is actually a more efficient radiator of luminous rays than is carbon. This is a point of considerable scientific as well as practical interest, and it is probable that before long further information on the subject will be obtainable.

ELECTRICAL MINING NOTES.

BY SIDNEY F. WALKER.

THE CAPTURE OF COAL MINES BY THREE-PHASE PLANT.

A feature which may fairly be said to belong to the past year is the definite capture of British coal mines by three-phase plant. It has been tried in some of the modern mines, and has done well. Its advantages are fully recognized, and every report shows that more and more colliery managers have been won over. One great advantage which three-phase apparatus has over continuous current had great weight with colliery managers, *viz.*, that the three-phase plant declines to be overloaded beyond a certain percentage. This it will be seen is an enormous advantage in colliery working. With continuous-current motors, if there is an overload, the motor will attempt to take it, like the willing horse that it is, with the result that its armature coils are badly strained; and if not then, at some later time, usually at some inconvenient time, it burns up, and the whole thing has to stop until a new armature is put in. Seeing that the motor may be working a mile or more from the pit bottom, which again may be 500 or 600 yards from the surface, and the electrician may be either at one of the other pits belonging to the colliery company, or in some other part of the workings, and has to be found before things can be rectified, the results, in the case of a dip pump, for instance, where the water has made a sudden increase, a very common case, may be very serious. With the three-phase, there is a certain figure, makers in England give it at double the normal load, at which the rotor slows up and refuses to turn. It is true that current may still be passing through the stator coils, unless the fuse blows, but even if this does happen, it is nothing like as serious as where the armature itself burns.

COMPRESSED AIR *versus* ELECTRIC ROCK DRILLS.

Referring to my remarks on this subject in some recent notes, the report of the commissioner of mines of the Transvaal mentions that each compressed air drill takes three horse-power to work, and that this three horse-power requires the expenditure of twelve horse-power at the compressor on the surface. Also that while the cost of the compressed air drill is £37, its upkeep is £5 per month. Against this, according to some tests made in Germany with Messrs. Siemens & Halske's electric rock drill, the power required was only 1.7 horse-power at the generator, which was from 1,000 to 2,000 yards away, the power required by a compressed air drill doing about the same work, being ten horse-power at the compressor.

NAKED CABLES IN MINE SHAFTS.

The idea of using naked cables in the shaft has exercised considerable fascination for colliery managers for some time. In the early days of electric lighting, cable makers did not know as much about insulation as they do now, and there was a good deal of trouble with cables eating in two, making connection with each other. Mr. Arthur Sopwith, the manager of Cannock Chase colliery, worked out a plan of using old steel wire ropes in place of copper. The wire ropes were embedded in a mixture of pitch and coal dust, and laid in brick troughs. In the shaft a somewhat similar method was adopted. At Cannock Chase the plan seemed to work well, but a good many other colliery managers and engineers tried to

follow suit with, in some cases, disastrous results.

I have referred to this, as some colliery managers are still using naked conductors in the shaft. They have permanently abandoned the old wire ropes, but are using copper conductors stretched naked in the shaft. This apparently gets over the difficulty of fixing insulation. A very serious trouble has arisen, however, in Scotland from this cause. The naked conductors in the shaft of a colliery supplied current at 500 volts for pumping purposes, and they came into contact with the signal wires. Two men who were walking along one of the main roads, where the naked galvanized iron signal wires were fixed, accidentally touched one of them, receiving a shock which killed them. I should perhaps explain that the usual method of signaling on engine planes in collieries is by pressing two naked iron wires together at any point of the road. The wires run parallel, a few inches apart, supported on insulators which are fixed to the props supporting the roof, and are connected to a bell and battery in such a manner that pressing the two together completes the circuit. The covering of the wires connecting the battery and bell is not usually very good, and hence if the naked 500-volt conductor rubbed one of them, as might easily happen, if the signals worked to the surface, connection with the 500-volt service would be made.

THE REPORT OF THE HOME OFFICE COMMITTEE ON THE USE OF ELECTRICITY IN COAL MINES.

The committee which was appointed by the Home Secretary to enquire into the use of electricity in coal mines has just issued its report. It is fairly full, and is accompanied by a set of regulations to be applied, if Parliament approves, to all coal mines in which electricity is employed. The committee examined fifty-six witnesses, including electrical and other experts, colliery owners and managers, miners' agents and miners themselves and one insurance company's representative. The committee also visited collieries in four districts where electrical apparatus is in use. They divide their remarks, and the regulations which are based upon the report, into two main divisions; the general principles governing the application of electricity to coal mines, and the particular work to which it can be applied, the latter being again divided into sections dealing with generating stations, cables and switches, stationary motors, portable motors, such as for coal-cutting machines, electric locomotives, electric lighting, shot firing, signaling, and relighting of safety lamps.

One of the most important pronouncements, which runs through the whole of the report and the regulations, deals with "earth." It is forbidden to use "earth" as a return, except where electric locomotives are employed, and then the trolley wires supplying the locomotives are to be fed from a separate generator, and the supply cables kept quite separate. This pronouncement will have a serious effect upon a large amount of work that has already been put in, principally in the west of Scotland, where an eminent firm of makers of electrical plant has made a specialty of uninsulated return cables. Its argument has been that if you connect one side of the supply service to "earth" in the manner it advises, by using concentric cables, and making the outer the return, you prevent accidental contacts with the cables giving rise to shocks. The weak point of this has always appeared to me to be the fact that you can not make sure of keeping the live conductor always buried. It must come to the surface at switches and fuses, and at the brushes of motors, generators, etc. The cables used by this firm are very carefully made, the outer consisting of iron wires, stranded in the usual way, the conductivity being made up to that of the inner by the addition of a copper wire when necessary, and the whole overlaid with lead, which is again armored outside, for certain work. Junctions, switches, fuses, etc., are enclosed in iron boxes, to which the concentric cables are brought, the outers being connected to the cases themselves. It will be evident that every time a man goes to change a fuse, he is liable to shock, and that there are other possibilities. In fact one case did occur in Warwickshire, where concentric cables were used. The cables having to be lengthened to reach a dip pump, a single cable was employed, the pump pipes being enclosed for the return, and a man met his death owing to an iron girder cutting through the insulation of the cable.

The committee decrees that all cases containing fuses, switches, junction pieces, and all frames and cases of motors and generators, are to be connected to "earth." Also for all cables using higher than 250 volts pressure armor is to be provided, which is also to be "earthed." With the first part of this I am in hearty agreement, but not with the latter. I have a great objection to placing any armor outside the insulation of a cable in a mine. There are a few cases where it is permissible as the least of possible evils, such as that of a three-core cable for three-phase working, to be fixed in the shaft, where it is difficult to obtain the necessary mechanical strength without. But my view is that for protection in other places, insulating material, something on the lines of a flexible duct, is the thing. Mechanical protection may be obtained by the intelligent use of insulating materials. As an alternative, the committee allows cables to be placed inside of metal pipes which are to be "earthed," and arrangements are to be made that water does not collect in bends or similar places. According to my experience, if cables are placed in pipes in this way, water will collect and will give trouble, no matter what precautions are taken. I may say, however, that this is practically the only point on which I am in disagreement with the committee. It appears to have done its work well, and in a thoroughly practical manner, and its regulations with a few exceptions are such as will add to the safety of the working miner, while not unduly cramping the development of the use of electricity in coal mines. It has, in my opinion, kept rather too close to the rules of the Institution of Electrical Engineers in the matter of wiring for electric light. This was perhaps inevitable, since its only adviser, apart from the witnesses who were called, was the electrical inspector of factories, who is a central station man. This is, however, a small detail.

ACCIDENTS DUE TO IGNORANCE.

The committee points out very forcibly that many of the accidents which have occurred have been due largely to ignorance of the killing powers of the current. It mentions the fact that while on the continent of Europe it is recognized that even 100 volts may be dangerous, with this knowledge, they have successfully used very high voltages. In England the fact that 500 volts was permitted, and that certain eminent engineers said that they knew of no case of injury from 500 volts, led to the assumption that, therefore, 500 volts was safe under all circumstances. I think that the real facts of the case are, we all thought until recently, that while nasty shocks might be got by touching a 500-volt service, there was no real danger till you got much beyond that. It gave us all a very rude awakening when men were killed by shocks of only 200 volts, alternating, and we are all wiser in consequence.

(To be concluded.)

Swiss Electric Railroading.

By Franz Koster.

RUNNING northeast from Lac Léman, better known as lake of Geneva, in Switzerland, is an interesting electric railroad of twenty-eight kilometres in length, the current for which is transmitted from the water power plant at Montbovon at 8,000 volts. The terminals of the road are at Lausanne, on the lake, and at Moudon, while the principal towns passed through are Epalinges, Montprovees, Mézières, Vucherens and Lyens, in the order mentioned. This is all elevated country, known as the Jorat. Formerly the main highway of traffic between east and west Switzerland was along this route, which connects Lausanne with Bern. The building of railways destroyed this traffic, and in order to secure a better connection with their markets the people of the Jorat and the authorities of the canton interested formed a company known as the Chemins de fer Regionaux Electriques du Jorat, for the promotion of the road, which has recently been put in operation. A considerable part of the traffic is derived from excursionists to Dhalet à Gobet, a resort at which is a shooting and drilling ground for troops, as Switzerland has an army of some 150,000 men. There is also a branch line from Epalinges to Savigny, a distance of five kilometres. The whole road and equipment have been erected by J. Jacob Rieter & Company, of Winterthur, Switzerland. For a greater part, the tracks are laid directly on streets or roads, there being only nine kilometres of specially constructed roadbed. There are eleven principal stations and eleven smaller ones. All stations have sidings, and at eight there are freight depots and at two there are repair and inspection sheds. All switches are automatic and require no attention except at the freight depots, where they are operated by the train crew.

To overcome the elevation of 300 metres (984 feet), which the highest point of the road reaches, it was necessary to provide grades of six per cent, while in one case seven per cent was encountered. The smallest radius is fifty metres. The rails are either Vignol or Phœnix rails, and are sixty and eighty pounds, respectively, per yard. The ties are of oak, but in some places the rails are laid directly on stone, and where this is done distance rods every 6.56 feet are provided.

As already mentioned, the greater portion of the road is on the streets, but this does not mean that no difficulty was encountered, for in many places the streets had to be leveled and corrected. The bridge over the river Broye, in Bressowaz, a stone structure, was widened on each side five feet with iron grilled concrete, while a new bridge of steel construction, 98.5 feet long by 20 feet wide, was placed over the Broye, in Moudon, instead of the former wooden bridge.

For transforming the voltage from 8,000 to 750 two substations are provided, one at Mézières and another at Epalinges. Each station contains two motor transformer groups of 200 horse-power each; one of which is used for railroad service, an asynchronous motor, and one for lighting, a synchronous motor, the latter being adapted for lighting by reason of its constancy, while the asynchronous motor group can sustain sudden demands for current without embarrassment. The lighting group can assist the power groups when the traffic is heavy.

The Rieter & Company motors are constructed for 8,000 volts and are direct-coupled with the generators, they make 500 revolutions per minute and have twelve poles. The bore diameter between poles is 1,000 millimetres (3.28 feet). The stator of the synchronous motor has seventy-two slots, each of which has sixty-two conductors of 2.2 millimetres diameter, insulated in mica three millimetres in thickness. The poles are wound with copper wire of 4.5 millimetres on the square. The efficiency of the groups is 93.5 per cent at full load, and the heating does not exceed thirty-five degrees centigrade above the normal upon continued operation.

The stator of the synchronous motor has 108 slots with fifty-two conductors each, while the rotor is fitted with 130 slots of two conductors each. The efficiency at full load is 92.5 per cent, and the heating forty degrees centigrade above normal.

The direct-coupled generators have a stator bore of 870 millimetres and the rotor a diameter of 850 millimetres. The rotor has 220 slots with two conductors each in fork-shaped winding. The generators develop an actual voltage of from 700 to 900, as desired. The efficiency of the generators is 94.5 per cent, and of the entire group 87.5 to 88.5 per cent at full load and 83.5 per cent at half load.

On opposite walls are switchboards, one for the three-phase high-tension circuits and the other for lighting and railroad work; the latter of 750 volts. The three-phase wires come in from an iron mast on top of the building and connect with fuses to the high-tension and switchboard. This switchboard bears volt and ampere-meters, the starting and regulating rheostats, a phase indicator and a switch for the synchronous motor.

Depot at Mézières, Lausanne-Moudon Railway System.

Directly over the switchboard on an iron shaft is arranged a series of horn lightning arresters, as shown in the illustration. Two other lightning arresters, with horns only one millimetre distance apart, are provided for the neutral wire, which protects the insulation of the motor against extreme high tension. Below the high-tension switchboard is a small cellar in which are placed transformers for lighting, measuring transformers and a small booster group.

The direct-current switchboard is arranged with double-pole switches upon a pair of bus-bars, of which one is in electrical connection with the rails and the other to the feeding wires for the trolley line. For the last one an automatic maximum current-breaker is fitted, which acts when the current becomes abnormal. A starting rheostat is provided for bringing the units into phase.

In the Mézières substation is a storage battery of 385 cells of 165 ampere-hours capacity. This acts as a reserve and buffer battery and can supply current during a short interruption of the current from

the power plant at Monlevoon. A small transformer motor of thirty horse-power furnishes the current for these cells.

The trolley wiring of hard drawn copper, 8.25 millimetres diameter, is for the most part of two wires; the branch to Savizny being of only one wire, of the same diameter. The cross-section of the wire is sufficient to prevent a loss of no more than twenty per cent of 750 volts (150 volts) by parallel switching of the two substations, even in case of heavy traffic.

It must be noted, too, that although this road is seventeen and one-half miles in length, it has only two substations from which the low-voltage current is drawn.

The wires are carried on wooden poles with steel arms the greater part of the way, but on curves and switches there are span wires. Where arms are employed a short length of suspension wire runs from the outer point inward and the trolley wire is attached to this. This wire is well insulated by means of an insulating bolt and a porcelain insulator; devices of American manufacture which have proved very satisfactory both as to mechanical stability and insulation service.

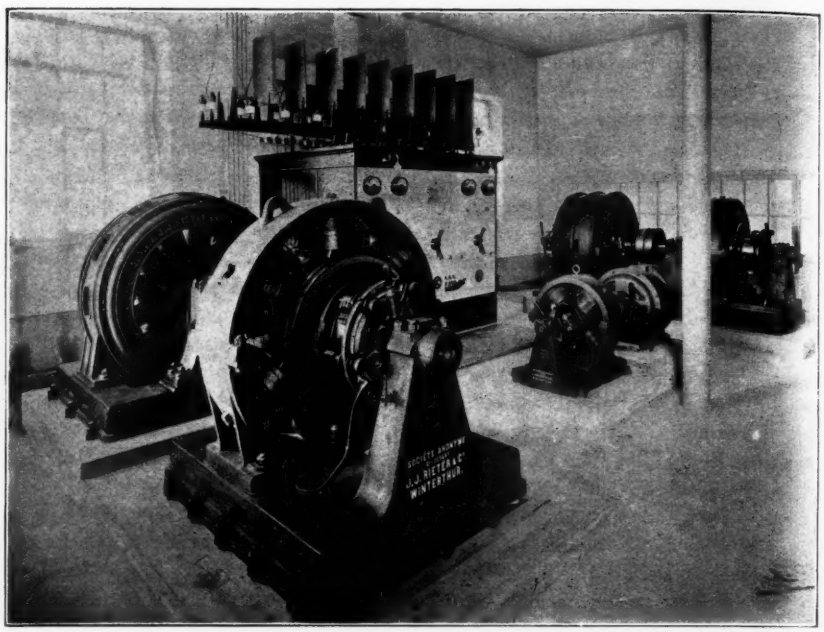
Regulating devices are placed every 1,000 metres (3,280 feet) to take up expansion in the trolley wire caused by changes of temperature. At every two kilometres (1.28 miles) are placed lightning arresters of the Carton system, while at the stations are section insulators provided with switches, by means of which sections of the road may be switched out, so that traffic will not be interrupted when some accident has damaged the electrical conductors on a portion of the line, or when delay has taken place for any reason, or while repairs are being made.

The rails act as a return for the current and an American rail-bond has been used which has been found highly satisfactory—the Columbia.

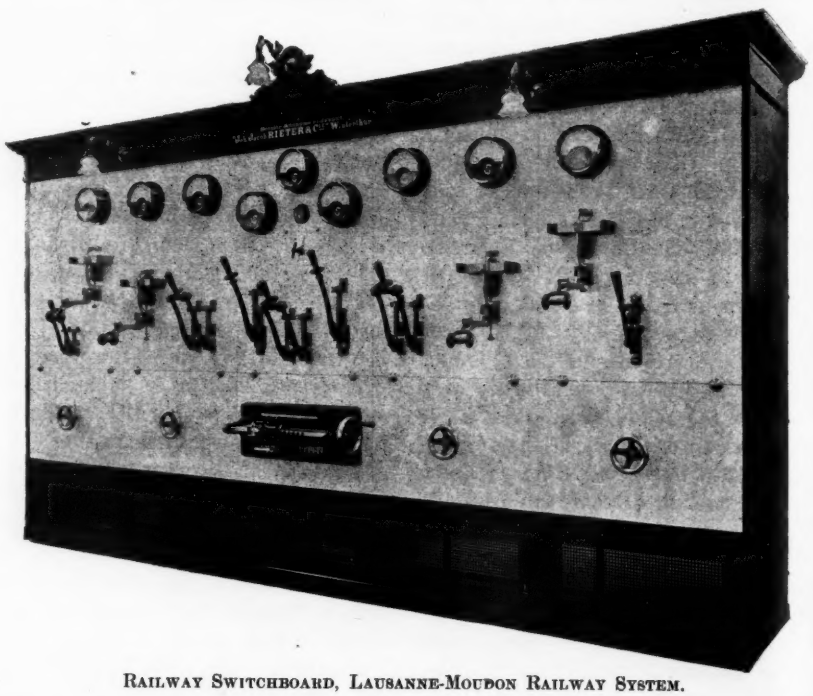
The rolling stock includes two and four-axle passenger and freight cars. The four-axle or double-truck car, as shown in the illustration, is 47.56 feet long and has a width of 10.54 feet. The necessities of traffic cause it to be divided into four principal parts, one for first-class passengers, one for third-class passengers, a smoking compartment and a mail and baggage room. Six doors are provided, the baggage doors on the sides, and at each end on both sides two sliding doors for passengers. The compartments are separated by swinging doors and the car has a seating capacity of thirty persons, while twenty more can find standing room on the rear platform and in the baggage room. All the windows may be easily opened and low ventilators are placed at the top of the car.

The axles are 5.1 feet from centre to centre and the trucks are 24.6 feet apart. The cars are fitted with a hand brake working eight shoes and also the Hardy brake, by means of which the trailers may also be braked from the motor car. The four-axle cars are provided with four motors, thirty-five horse-power, one on each axle. They can for a short time develop fifty horse-power each without dangerous warmth or sparking on the collector.

In starting, the motors are switched in two in series and when under way in parallel. The usual voltage is 750, but with batteries in a voltage of 900 is supplied an unusual working tension. On account of this, at first some difficulty was experienced in switching in in parallel. The motors are four-pole and have a field diameter of 1.3 feet with a width of 0.65 foot. The armature winding is of the so-called Schabloness (template) winding, and has thirty-seven slots of a section of 12.5 by 30 millimetres. Each unit contains thirty conductors of 2.6



INTERIOR OF SUBSTATION AT MÉZIÈRES, SHOWING HIGH-TENSION SWITCHBOARD.

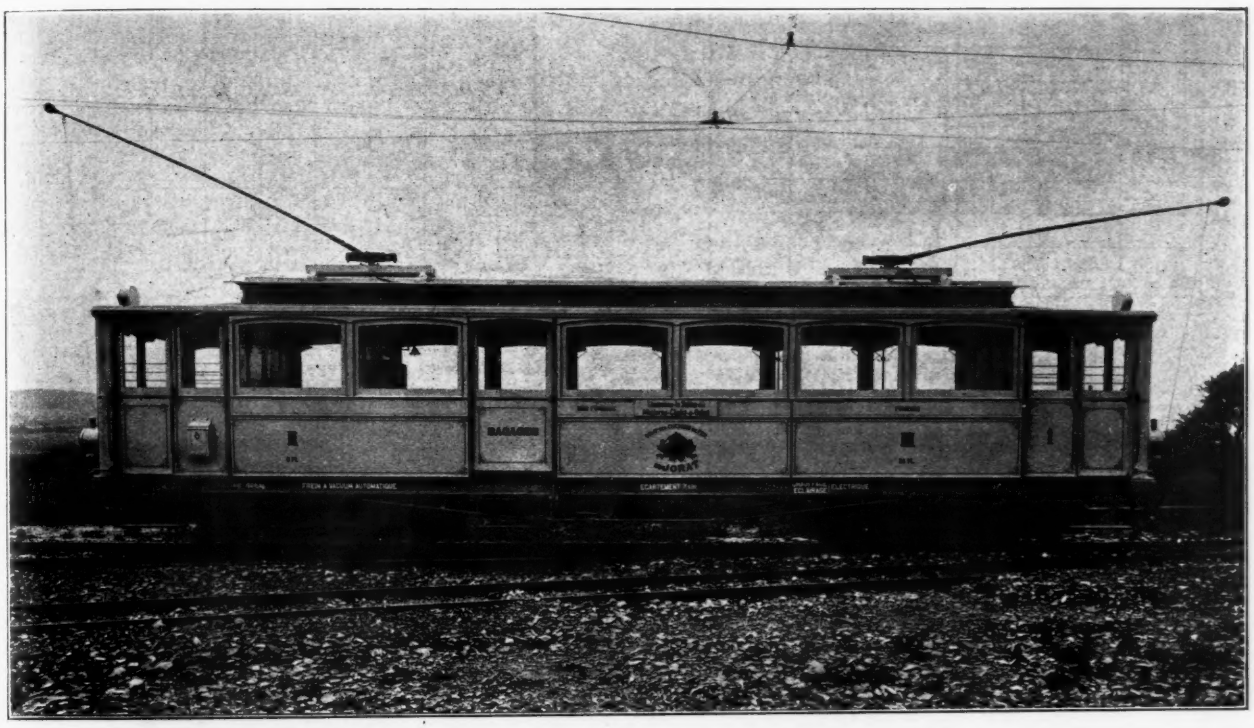


RAILWAY SWITCHBOARD, LAUSANNE-MOUDON RAILWAY SYSTEM.

millimetres diameter. The motors are geared 1 to 4.93 and their efficiency at full load, including gearing, is eighty-seven per cent. At 360 revolutions per minute the cars make twelve kilometres per hour at the steepest grade, and at 1,060 revolutions the speed is thirty-five kilometres on even track level. The motors are so constructed that upon an incline the momentum of the car (or in stopping) is translated into electrical energy which is consumed in the starting and braking rheostats. These rheostats are located under the floor of the car.

The two-axle cars are similar except to size and number of motors and they are not divided into compartments. All cars are electrically heated and lighted. The low trolley so generally and advantageously used in Europe is not here used, on account of white frost (the formation during the whole year of a dew in mountainous districts which has the appearance of snow) on the underside of the trolley wires.

The traffic between Lausanne-Chalet à Gobet is served by these cars, while the larger ones are used on the through road Lausanne-Moudon. At Moudon connection is made with trains of the Jura-Simplon railroad, on which is the Simplon tunnel, 19.731 kilometres (12.332 miles) long, the longest tunnel in the world.



THE DOUBLE-TRUCK CAR USED ON THE LAUSANNE-MOUDON RAILWAY.

Villiers and Edison.

Villiers, like most European poets, had a mighty ideal of America and the Americans. He believed this country and its institutions to be what Thomas Paine, Jefferson and a few other genuine patriots hoped it would be. He entertained for Thomas Alva Edison the deepest admiration. His novel, a grotesque book, "The Eve of the Future," contains a fanciful account of Menlo Park and its "terrifying proprietor." When Edison went to the Paris exhibition in 1889 he became acquainted with Villier's novel. He read it at a sitting and expressed himself thus: "That man is greater than I. I can only invent. He creates." He did not meet the author, who was mortally ill, though an attempt was made to bring the Frenchman and American together. The leading motive of "The Eve of the Future," pushed to an ingenuity bordering on insanity, is the construction of an artificial woman which when wound up enacts in every respects the daily life of a cultivated lady. Need I add that the theme is treated to delirious lengths!—*James Huneker in the New York Sun.*

Electrical Equipment of the Great Western Railway.

The London *Electrician* announces that contracts for the boilers for the station which will supply power to the Hammersmith and city line of the Great Western Railway have been let to Babcock & Wilcox. The Electric Construction Company will supply the 6,600-volt three-phase generators, which will be driven by Belliss engines. These engines will be of the Belliss & Morcom's high-speed standard design, with forced lubrication. They will be eight in number, and each will develop 1,080 brake-horse-power at normal load, and 1,250 brake-horse-power at maximum load. The engines will be of the triple-expansion three-crank vertical enclosed type, to take steam at a pressure of 190 pounds, with 500 degrees Fahrenheit of superheat at the stop valve. In addition to the eight large sets there will be two auxiliary sets for lighting and power work. Four surface condensing plants will be installed. Each condenser will have 4,200 square feet of cooling surface. The circulating pumps will be of the centrifugal type, driven by small three-phase induction motors.

The Journal of the British Institution of Electrical Engineers.

The January issue of the British Institution of Electrical Engineers contains the inaugural address of President Robert Kaye Gray; a report of the Gilbert tercentenary commemoration, and the following papers and discussion: "The Testing of Electric Generators by Air Calorimetry," by Richard Threlfall, and "The Slow Registration of Rapid Phenomena by Strobographic Methods," by E. Hospitalier.

The Edison Accumulator.[1]

The discussion upon the paper read by Mr. W. Hibbard before the British Institution of Electrical Engineers on November 26 took place on January 28. The following is abstracted from the discussion as given in the London *Electrician* for February 5:

Dr. J. A. Fleming said that he had tested an Edison accumulator similar to that tested by Mr. Hibbard, and that his results were in perfect agreement with those obtained by Mr. Hibbard. So far as weight and capacity were concerned, the cell was not distinctively greater or not largely greater than that of many light-weight lead cells. On the other hand, there seemed clear evidence that the durability of the plates might be very much greater. There was also good evidence that the disintegration or deposit of active material was greatly reduced as compared with the lead cell, there was no local action between the active material and the supports, and that the cell, in consequence, would bear being left idle. It had an enormous capacity of taking up a charge.

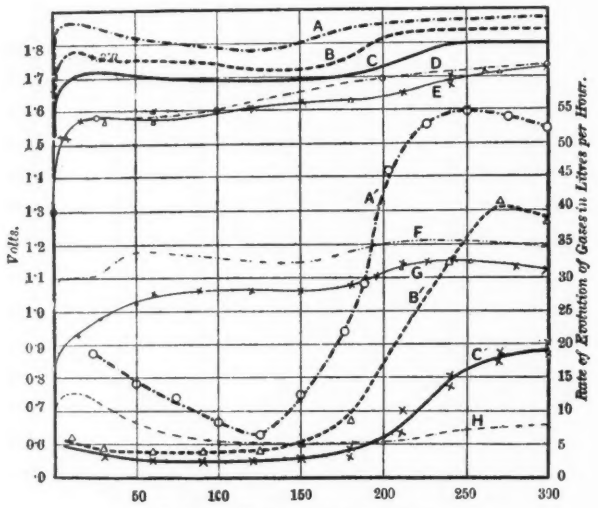


FIG. 1.—EDISON CELL CHARGE.

AMPERE HOURS.—A=100 ampere rate. B=60 ampere rate. C=30 ampere rate. A′=gas evolved at 100 ampere rate. B′=gas evolved at 60 ampere rate. C′=gas evolved at 30 ampere rate. D=E.M.F. at 100 ampere rate. E=E.M.F. at 60 and 30 ampere rates. F=P.D. between iron electrode and case at 100 ampere rate. G=P.D. between iron electrode and case at 60 and 30 ampere rates. H=P.D. between nickel oxide electrode and case, common to 100, 60 and 30 ampere rates.

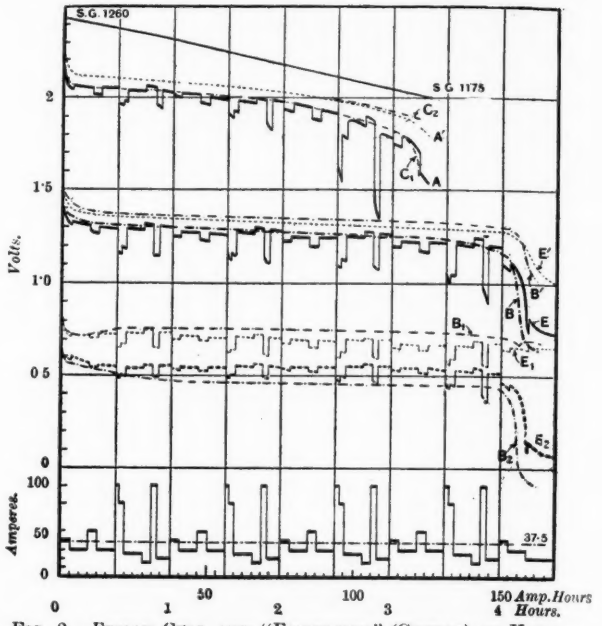


FIG. 2.—EDISON CELL AND "ELECTRICIA" (CONTAL) AT VARYING RATES (37.5 AMPERE HOURS PER HOUR).

A, P.D. Contal Cell at varying rates. A′, E.M.F. Contal Cell at varying rates. C_1, P.D. Contal Cell at flat rate 37.5 amps. C_2, E.M.F. Contal Cell at flat rate 37.5 amps. E, P.D. Edison Cell at varying rates. E′, E.M.F. Edison Cell at varying rates. E_1, P.D. Negative Electrode to case E_2, Positive Electrode to case. B, P.D. Edison Cell at flat rate. B′, E.M.F. Edison Cell at flat rate. B_1, Negative to cell. B_2, Positive to cell.

Mr. E. J. Wade made an interesting point that the voltage variation of the Edison cell could not be due to changes in the concentration of the electrolyte, as the electrolyte takes no part in the reaction, other than as a transferrer of oxygen. This action raised the question, whether the usual explanation for the variation of voltage of the lead cell, which is ascribed to changes in the concentration of the electrolyte, was really the true one. He had prepared some lead cells with very porous active material, and had found charge and discharge curves very similar to those of the Edison cell.

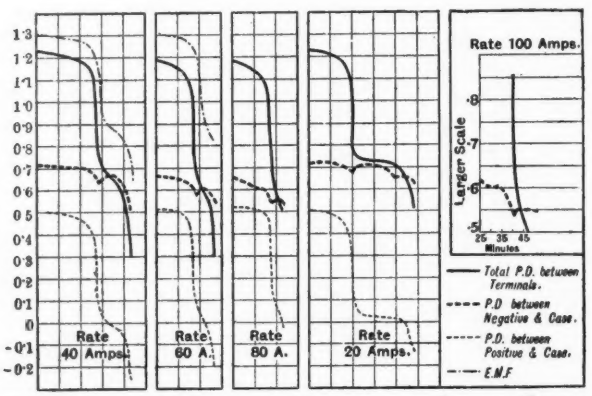


FIG. 3.—ENDS OF P.D CURVES ON DISCHARGES AT CONSTANT CURRENT SHOWING INDIVIDUAL BEHAVIOUR OF ELECTRODES.

Mr. H. L. Joly had also tested one of the Edison cells, and his results agreed with those of Hibbard, Hospitalier and Janet. He did not know of any cell in which Peukert's coefficient was so low, and he had come to the conclusion that it was perfectly safe to take it at 1.1. He exhibited the charge and discharge curves of an Edison cell at different rates, and compared the characteristics of the cell with those of a Contal lead cell, the two sets of curves being very similar.

The curves shown in Fig. 1 represented charges given to an Edison cell at three different rates; curve A showing the rise in potential difference when charging at 100 amperes; curve B, when charging at sixty amperes, and curve C, when charging at thirty amperes. The three curves below represent, respectively, the rise in voltage under the same conditions. These curves show that the difference of potential remains constant after the cell has received 250 ampere-hours, but the charging voltage continues to rise, indicating that the cell was fully charged by the 250 ampere-hours. Curve F represents the difference of potential between the iron electrode and the case when charging at the 100-ampere rate. Curve G is a similar curve for the sixty and thirty-ampere rate.

In Fig. 2 curves are given for the performance of the Edison cell under varying rates of discharge and similar curves for a lead cell having a capacity of 140 ampere-hours and discharged at a rate of 37.5 ampere-hours obtained by a series of varying rates. This cell gave 112.5 ampere-hours. Taking the average voltage as 1.93, the watt-hours were 217. The Edison cell, worked in the same way, would give 150 ampere-hours or 189

[1] See ELECTRICAL REVIEW for December 12, 1903.

watt-hours, taking the average voltage at 1.26. Each of the lead cells would weigh ten kilogrammes, and the total weight of forty-four would be 440 kilogrammes. Each Edison cell would weigh 7.7 kilogrammes and seventy of these, to obtain the same voltage, would weigh 539 kilogrammes. Fig. 3 shows the comparative behavior of the two electrodes obtained by means of an auxiliary electrode. Cadmium was tried, but the containing vessel gave better results. This showed a drop on the negative electrode and a recovery at the same time that the drop occurred on the nickel electrode.

Mr. Hibbard thought that the change in voltage of the Edison cell was due to a change in the resistance. His experiments showed that toward the end of a discharge the resistance of the cell increased rapidly. He had found that by breaking up one cell which had come to grief, the amount of active material which had worked its way out of the pockets during a run of 3,000 miles was only one two-thousandth of the total amount of active material of the cell.

Replying to the criticism that he had used a heavy car and assumed low efficiencies for the motors, he said that he had put the case as strongly as he could against the Edison cell.

LETTERS TO THE EDITOR.

The American Electrochemical Society.

To the Editor of the Electrical Review:

In common with most of the directors of the American Electrochemical Society I signed a petition for a constitutional amendment, making the president, vice-presidents and managers ineligible for reelection. I must therefore decline to be a candidate for reelection to the office of vice-president, for which I am officially informed I have been nominated.

At the same time, in view of the very handsome vote which my friends have cast for me in nomination for the presidency of the society, and of the fact that the board of directors is not endorsing any one for that office, I announce myself as a candidate for the presidency.

Henry S. Carhart.

Ann Arbor, Mich., February 16, 1904.

Electrical Mining Notes.

To the Editor of the Electrical Review:

I have been very much interested in the occasional contributions from Mr. Sidney F. Walker, regarding the use of electrical apparatus in mining operations in Great Britain. In your issue of January 16, Mr. Walker discusses the use of electrical apparatus in the South African gold fields. At one point he refers to several motors in the Knight's Deep mine, which, after being under water for two and one-half years during the war, "were taken out, dried and put to work again with satisfactory results," stating further that "the name of the maker is not given." It occurs to the writer that more specific information regarding this installation may be of interest.

Several months before the late South African War, there were installed in the Knight's Deep mine thirty-six fifteen-kilowatt General Electric type "H" transformers and twelve Knowles horizontal triplex pumps, each operated by a fifty-horse-power General Electric induction motor. When the war broke out and the mine was shut down, the water rose so rapidly that it was impossible to remove the pumps, motors and transformers, and consequently they were left under from 500 to 1,000 feet of water. Two and a half years later, when peace had been declared, the shaft was unwatered and the electrical apparatus was removed to the surface. Three of the motors were stripped and completely rewound, but the condition of the insulation seemed to indicate that the rewinding of the motors might not be absolutely necessary. The remaining nine motors accordingly were thoroughly dried in an oven heated by a steam coil, and then soaked in oil. After this treatment the motors were given a rigid test and placed in regular service again in the mine. The type "H" transformers were treated in the same manner as the induction motors, with equally satisfactory results. This occurrence certainly emphasizes the preeminent suitability of electrical apparatus for the severe conditions characteristic of mining operations.

W. B. Clarke.

Schenectady, N. Y., February 16.

Wireless Telegraphy in Brazil.

U. S. Consul K. K. Kennedy, at Para, Brazil, reports that a wireless telegraph system has been tested between Manaos and Iquitos during the past few months. The results have been so satisfactory that the cable company has bought the right to use the system between Para and Manaos, and arrangements are now under way for its installation. It is thought that this development will be of great importance to the interests of the Amazon valley, as to maintain a reliable telegraph service between the up-river towns is practically impossible, and it seems equally impossible to keep a cable line in steady operation. The present cable was laid recently, and is said seldom to be in working order more than one or two days per week. The rapid and violent fluctuations of exchange in that country render it important that merchants and shippers keep in close and uninterrupted touch with their branch houses and agents at all points, and this it is hoped the wireless system will do.

The National Electric Light Association.

The following companies have recently been added to the active membership list of the National Electric Light Association:

Montgomery Light and Water Power Company, Montgomery, Ala.

Hot Springs Water Company, Hot Springs, Ark.

Monterey Gas and Electric Company, Monterey, Cal.

Moscow Electric Light and Power Company, Moscow, Ida.

Freeport Railway, Light and Power Company, Freeport, Ill.

Richmond Light, Heat and Power Company, Richmond, Ind.

Keokuk Electric Railway and Power Company, Keokuk, Iowa.

Waterloo & Cedar Falls Gas and Electric Company, Waterloo, Iowa.

The Electric Railway, Light and Ice Company, Junction City, Kan.

Clinton Gas Light Company, Clinton, Mass.

Great Barrington Electric Light Company, Great Barrington, Mass.

Edison Sault Electric Company, Sault Ste. Marie, Mich.

Edison Electric Light and Power Company, Amsterdam, N. Y.

The Allegheny County Light Company, Pittsburg, Pa.

Newport & Fall River Street Railway Company, Newport, R. I.

Bristol Gas and Electric Company, Bristol, Tenn.

Burlington Light and Power Company, Burlington, Vt.

The Washington Water Power Company, Spokane, Wash.

O. I. Newton's Sons Company, Wisconsin.

The following new associate members have been added to the list:

Ford, Bacon & Davis, New York city.

American Conduit Company, New York city.

B. D. Nath, Schenectady, N. Y.

William I. Taylor, Schenectady, N. Y.

Nearly two hundred questions have already been received for the "Question Box" of the twenty-seventh convention of the association, to be held in Boston, Mass., May 24, 25 and 26. The preliminary list will be sent out soon and answers called for. This feature of the association's work is expected to be even more instructive and of greater practical value than last year's department work.

The Conduit Work at the New Power-House of the Edison Electric Illuminating Company, Boston, Mass.

AN ESSENTIAL part of every electric generating station to-day is the underground conduit system. Few important urban systems contemplate any but underground lines for distributing their output, for the additional expense, as compared with an overhead line, is more than paid for by the increased safety and the immunity from interruption from outside causes.

Necessarily, the most complex part of an underground system is that section which leads the conductors from the switchboard room to the street, where the main conduit lines separate and pass to various sections of the locality supplied. This part of the conduit line must collect the wires as they drop from the board, group them properly, and lead them to the distributing manholes in the street. When a system of this kind is laid down, upon the construction of a new station, the future growth of the plant is always considered carefully, and what is thought to be ample provision is made; but the actual growth of the successful generating station has, in a number of instances, exceeded that anticipated, making necessary an enlargement of the conduit lines. This has been the case with the L street station of the Edison Electric Illuminating Company of Boston. This station was put into service a little over six years ago, but it is now, during the heavy load period, carrying an overload of about fifteen per cent. To meet the increased demands, a new station is being built alongside the old, and a conduit double the size of the old was necessary to handle the output of both stations, and the location of the new station necessitated the abandoning of the old line and the construction of an entirely new one. Moreover, the requirements of the work were such that new conduit must be constructed and the cables transferred from the old to the new without interrupting the service of the station. The contract for carrying out this work was secured by Mr. G. M. Gest, of New York and Cincinnati, whose specialty is the construction of conduit systems, and the new conduit system is now nearly completed, the work having been done, in spite of very difficult obstacles, without any interruption to the service.

Fig. 1 shows the plan of the new system, and will also make clear the character of the old system which is superseded. At the bottom is L street, along which to the right and left run the distributing lines. The locations of the new boiler house, the new turbine house and the present station are indicated. Between the new turbine room—for steam turbines are to be installed in the station—and the present generating station is an alley about thirty feet wide, which will be walled in and roofed over to form the new switchboard room. The old switchboard is just within the wall of the present power station, and the cables reach this through ducts passing under this wall. There were forty-eight of these ducts, divided into six groups and running to six manholes arranged in two parallel rows of three each, and located in the alley. From these two rows of manholes two duct lines ran along the alley to the left, to a pair of manholes placed about where the extreme left wall of the new switchboard room is indicated in the figure. From these manholes two duct lines started and were brought together to form a single line of forty-eight tubes, which passed out under the new turbine and boiler rooms to two manholes side by side in the street, and from each of which branched to the right and left a twelve-duct line. There was also another nine-duct line coming out from the old station and running almost paral-

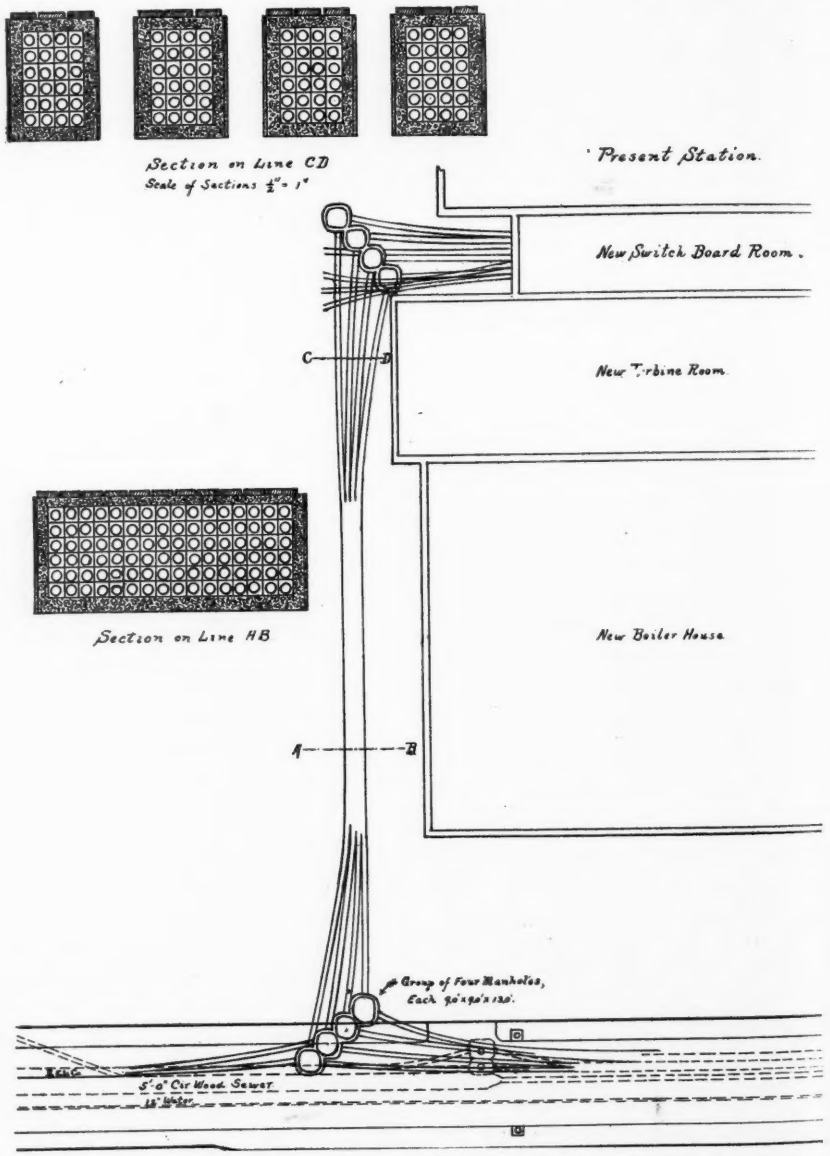


FIG. 1.—PLAN OF NEW CONDUIT SYSTEM, EDISON ILLUMINATING COMPANY OF BOSTON.

lel with the station wall to a manhole in the yard beyond the power-house.

As already mentioned, the plan for the new power-house called for a new conduit, double the size of the old, that is, of

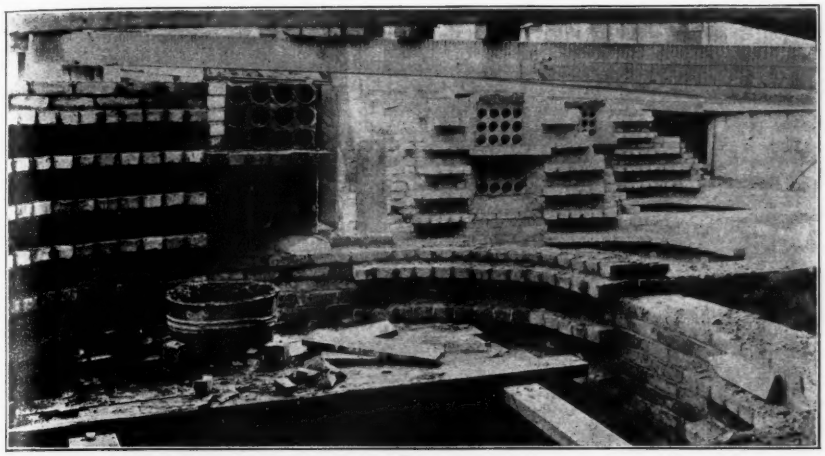


FIG. 2.—MANHOLE, SHOWING CABLE WAYS AND ENTRANCE TO DUCTS.

ninety-six ducts, leading from the switchboard room to the street, and laid beyond the walls of the power-house. Half of this is to accommodate the cables from the old station, the remainder providing for new cables.

The plan of the new system is that shown in the figure. It will be seen that there are four duct lines passing out to the left from under the switchboard room to four independent manholes laid at an angle of forty-five degrees to the centre line of the switchboard room. From these manholes four ducts are carried out to four similar manholes laid partially under the street and partially within the company's ground. These duct lines are brought together to form a single line of ninety-six ducts for a considerable part of the run, but fan out as shown before reaching the manholes. To the lower two of the group of manholes at L street are run the duct lines for the old system. In the lower one a twenty-four-duct line runs to the right, and a similar line of twenty-four is carried to the left to the old manhole on L street, but not shown in the figure. From the next manhole in order twelve ducts are carried to the second of the old manholes, and a twenty-four-duct line is run to the left to a new manhole on L street, close to the old one, but also not shown in the figure. From the other two manholes of this lines will be laid, but these have not yet been put down. Each manhole of the two groups of four is nine feet square and thirteen feet six inches deep from the surface of the ground. At the bottom of each is laid one foot of Portland cement concrete, upon which the brick walls of the manhole are erected. The construction is shown in Fig. 2, which gives a view of the upper part of three unfinished manholes. This figure shows clearly how the ducts are let into the wall, and the shelves for carrying the cables around from one line to another. The construction of these manholes

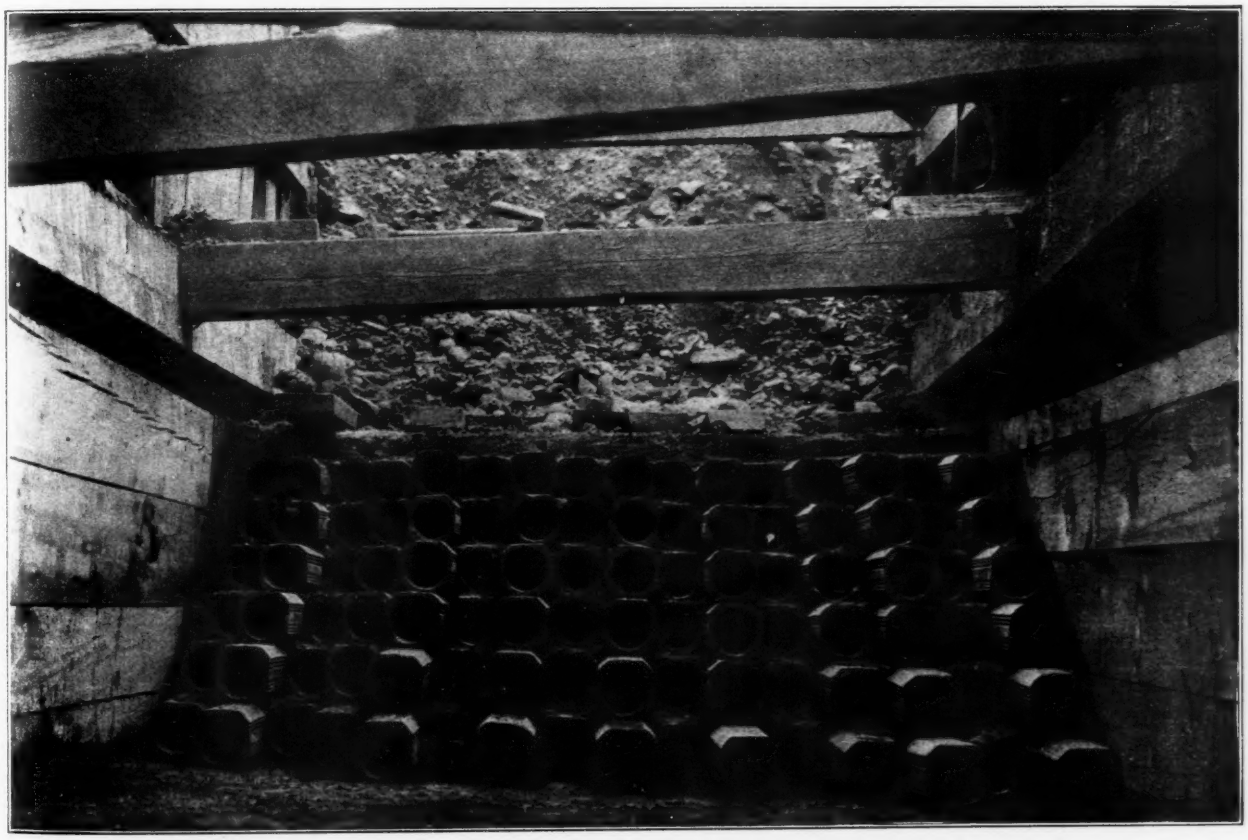


FIG. 3.—STRAIGHT LINE OF NINETY-SIX DUCTS IN CONDUIT.

was, at times, quite troublesome, as the power station is just on the edge of Boston Bay, and the excavation winds down several feet below mean low water.

In constructing the line of ninety-six

ducts connecting the two groups of manholes, it was necessary to excavate a ditch about nine feet deep; but as this line of ducts passes over the tunnels for the intake and discharge of the condenser water, Figs. 3 and 4, the former showing the single line of ninety-six ducts, and the latter indicating the method of fanning the ducts out into four groups of twenty-four each.

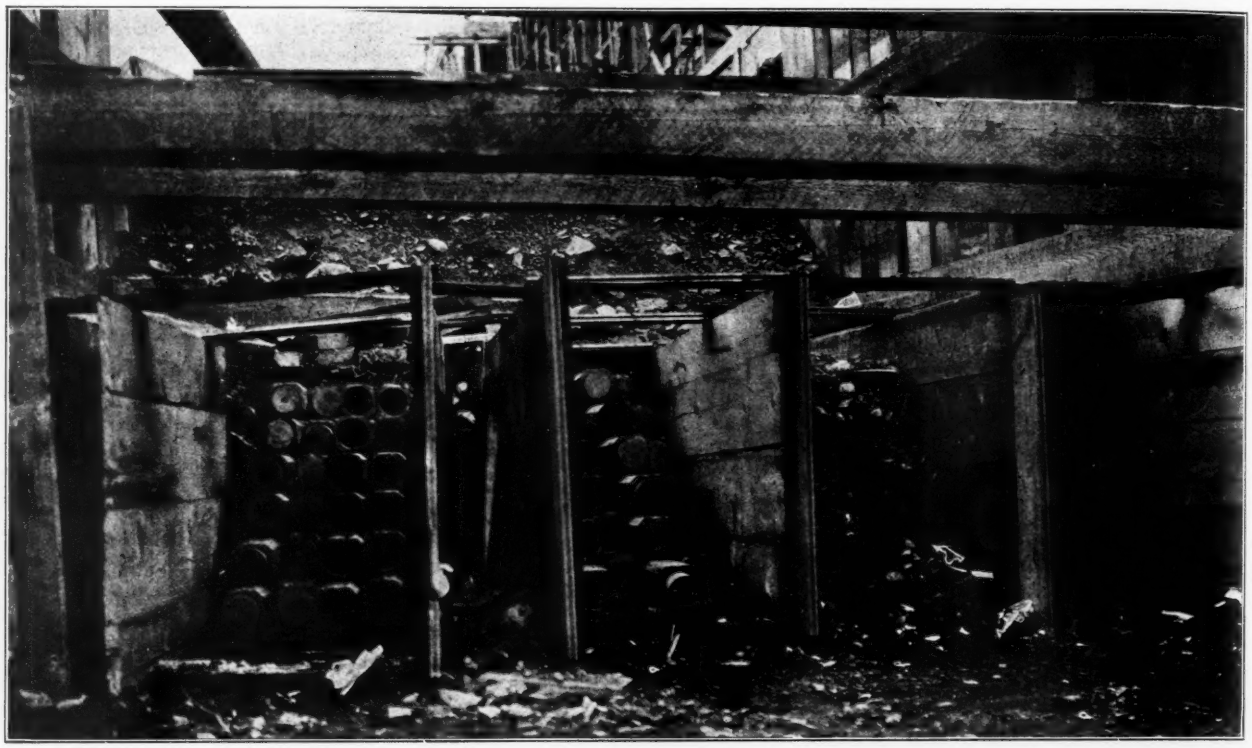


FIG. 4.—THE CONDUIT FANNED OUT IN FOUR SECTIONS OF TWENTY-FOUR DUCTS EACH.

it was important to provide against any settling of the soil. For this purpose a ditch thirty feet deep, ten feet wide and forty feet long was excavated and filled with concrete up to the level of the bottom of the duct lines. This gives a solid foundation, and removes all risk of settling of the soil. The construction of these lines of ducts is clearly shown in

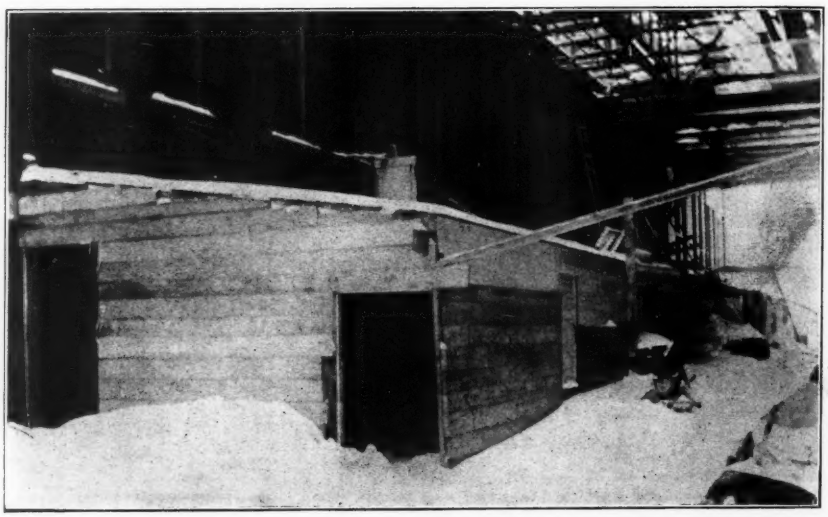


FIG. 5.—LONG SHED, UNDER WHICH WORK OF ERECTING CONDUIT WAS CARRIED ON DURING WINTER.

The construction of the duct lines running from the upper group of manholes under the new switchboard room was accomplished under rather difficult conditions. From the lower two—that is, the nearest two to the corner of the new station—two lines of twenty-four ducts each have been run to the left and dead-ended there. These two lines could not be brought together into a single line because of a line of pilasters coming between them. From the upper pair of manholes two lines of twenty-four ducts each start, running together to form a single line of forty-eight. This line rises gradually, and at the point where it is opposite the old switchboard the upper row of twelve ducts branches off and passes down into the basement of the old power-house. A little further along a second branch turns off, this accommodating eighteen of the duct lines; and still further along, twelve ducts branch off, and then the remaining six. The object in raising this line was to allow three lines, containing in all 144 ducts, to be carried under and brought up to the back of the switchboard between the four branches which run into the old power-house, and which have just been described. In addition to the four branches passing into four bays in the basement of the old power-house, there is also the nine-duct line mentioned previously.

In laying these ducts, it was necessary to cut away half of one row of three manholes of the old system, and tie up the cables so as to be out of the way of the masons. There is also an eight-inch sewer running up the alley under the ducts, which added slightly to the complications. As the new lines were completed, the cables could be disconnected one by one and drawn out of the old

system and then redrawn into the new. Some lines, however, could not be interrupted, this being the case with the nine-duct line running out of the old power-house.

These conduits consisted of a cement-lined pipe. The cables were stripped by cutting off the iron and smashing the cement tube. As this was done, the cables were raised up and tied out of the way, and the floor prepared for the new ducts. These, as will be seen, are clay conduit, and each piece of tubing was split longitudinally by means of a cold chisel, one-half laid on the concrete bed, the cable placed within it and covered with the second half, and the whole piece then coated with cement. In this way the entire line was run without cutting any cable. This same process was followed in transferring the cables from the old ducts on L street to the new.

Returning to the work under the new switchboard room, in addition to the duct lines already mentioned as running under this room from the four manholes, there are two other lines intended for future use. One of these contains seventy-two ducts, which fan out after leaving the power-house into three lines of twenty-four ducts each. The other line contains twenty-four. These two lines pass under the other system, one running close to the wall of the new station, and the other passing under the second manhole from the corner of the new power-house. These two lines have been dead-ended, as they can not be completed until the old manholes have been completely removed. Eventually they will terminate in the yard in four manholes similar to the present group under which they pass. The first of these lines is down about fourteen feet six inches, or six feet below mean low water. The other is down about seventeen feet six inches, nine feet below mean low water.

As already mentioned, in most of this work the inflow of water had to be contended with, and constant pumping was necessary. Another unfavorable condition was the severe weather, and it was necessary to carry out a good part of the work during the winter. To provide for this, and at the same time to protect the cables exposed by cutting away the manholes, a shed was constructed against the wall of the old power-house, as shown in Fig. 5. This allowed the work to be pushed vigorously, and more or less independently of the weather.

From this description some idea may be had of the rather trying conditions under which the work had to be carried out, as well as of the unusual complexity of the system. Practically all the old cables have been transferred to the new ducts, and so far without mishap. The work as a whole is an excellent example of modern conduit laying. The plans were drawn up under Mr. F. H. Clark, chief engineer of the Boston Illuminating Company, and the work was supervised by Mr. W. B. Nichols, assistant engineer.

News from Mexico.

(From Our Special Correspondent.)

Developments in electrical lines in the republic of Mexico are proceeding apace. As a matter of current happenings, all industrial lines are being developed on a very much larger scale than at any previous period of Mexico's history, whether in mining, manufacturing or railroad enterprises. It is safe to assume, however, that progress in electrical developments exceeds that of other industrial enterprises in the republic, while the future gives promise of much greater things. There are many reasons for this. Mexico is but awaking to the wonderful possibilities which her resourceful soil and mineralized territories present. American capital is pouring into the country, and within the next few years magical indeed will be the transformation from steam to electrical forces. The enormous cost of fuel in Mexico, which has so much to do with minimizing dividends, which, together with the magnificent and powerful water falls in every part of the republic, will do much toward effecting the change referred to. The application of electrical power will therefore be very substantially increased as Mexico advances in mining and manufacturing.

The demand for electricity for illuminating purposes alone, in the towns and cities of the republic, is increasing, and will assuredly keep many electrical machine manufacturing plants in the United States busy for a long time.

A local company in the city of Campeche, state of Campeche, is making arrangements for the establishment of an electric plant. Address the alcalde of the city of Campeche, Campeche, for information.

The La Esperanza mines, in the state of Guanajuato, will install electrical pumps. Address Dwight Furness, American consul, Guanajuato.

R. M. Burke, former United States consul at Chihuahua, has obtained a concession to take 630 litres of water per second from the San Jose del Sitio river, in the state of Chihuahua, at the point where it joins the Monoava river, for the installation of an electric power plant.

The United Mining and Development Company, 666 Broadway, New York city, will erect, in addition to its 400-horse-power electrical plant, an electrical plant of 300-horse-power capacity. This is merely one of the many plans and changes contemplated, the company having decided to expend $2,000,000, gold, on these lines on its extensive properties during the next three years. E. A. Fays is general manager, Meretaro, where the company's properties are located.

An electric lighting plant has been decided upon by the municipal authorities of the city of Culiacan, state of Sinaloa.

The Altamera Mining Company, of Etzatlan, Jalisco, has struck rich gold and silver veins, and it is the intention of the company to increase its capital to operate the property on a large scale. Much machinery will be needed, including electrical. D. Ryan, a member of the company, is now in Chicago for the purpose of increasing the capital.

The Amparo Mining Company, of the state of Jalisco, has ordered an electric light and power plant to be installed on its property at Etzatlan, state of Jalisco.

Charles Barbier and associates, of Cusihuiriachic, Chihuahua, have secured a three years' lease on the famous La Raina mine. The mine will now be exploited on a large scale, and a general line of mining machinery will be in demand.

Victor M. Baschi & Brother, of the City of Mexico, have just placed a large order for medium-sized direct-current generators with the Northern Electric Manufacturing Company, 29 Broadway, New York city.

The American-Mexico Mining and Development Company, main office in Chicago, and branch in Torreon, Mexico, has placed an order with the General Electric Company, of Chicago, for the erection of a $50,000 electric plant at the Valedena camp, near Torreon.

An American company is treating for the purchase of the tramways of Hermosillo, capital of the state of Sonora. The project is to transform the mule power into electric traction and extend the system to neighboring towns. Address the alcalde, Hermosillo, Sonora. J. B.

City of Mexico, February.

A New Hydroelectric Station in Switzerland.

A hydroelectric power station is now being constructed at Engelberg-Obermott, for the purpose of distributing electrical energy for power and lights to the city of Lucerne, which is about thirty kilometres from the generating station. The output of the station will be 10,500 horse-power, and transmission will take place by means of transformers at 27,000 volts. A substation will be placed at Lucerne, where the tension will be lowered to 2,600 volts for the city and its suburbs. The station will, at the same time, supply the needs of Engelberg, of the canton of Obwalden and the country lying between it and Lucerne. The electrical equipment is being supplied by the Oerlikon Company.

THE CONDUCTIVITY OF THE ATMOSPHERE AT HIGH VOLTAGES.[1]

BY HARRIS J. RYAN.

SYNOPSIS.

The present paper gives an analysis of the factors that are responsible for the nature of the atmospheric loss occurring on high-voltage lines, as reported by Mr. Charles F. Scott in his paper that was published in the A. I. E. E. Transactions, vol. xv, p. 531, 1898, based upon results obtained by himself and Mr. Ralph D. Mershon. The analysis shows that the equation

$$E_{max} = 2055 \log_{10}\left(\frac{s}{r}\right) D' (r + d) \times 10^{10} \qquad (10)$$

expresses the relation between the voltage, conductor sizes, and separation at

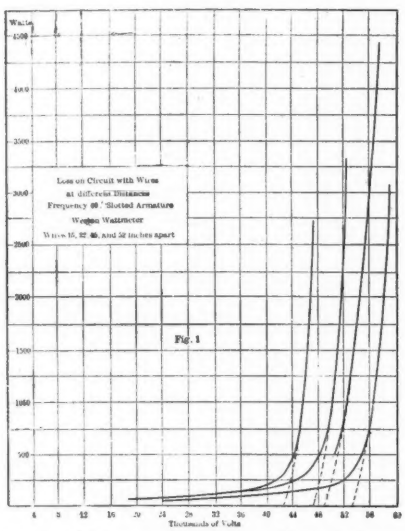


FIG. 1.—CONDUCTIVITY OF THE ATMOSPHERE AT HIGH VOLTAGE.

which the sudden rise occurs in the curve of "loss between wires" at ordinary barometric pressures and temperatures wherein

E_{max} = the maximum value of the voltage-wave applied to the line.

r = the radius of the line conductor in inches.

s = the separation of the line conductors from centre to centre in inches.

d = the distance from the conductor surface at which the strain due to the electrostatic field causes initial atmospheric rupture.

D' = the strength of the electrostatic field of force (dielectric flux density) that will electrically rupture the atmosphere at the distance d from the surface of the conductor having a radius r measured in coulombs per square inch.

[1] A paper presented at the 184th meeting of the American Institute of Electrical Engineers, New York, February 26, 1904.

To this is added an account of the experiments that were made to determine the above values of d and D' in relation to r and the effects due to barometric pressure and temperature changes and to the presence of moisture.

The values found for d and D' in relation to r at a barometric pressure of 29.5 inches of mercury and a temperature of seventy degrees Fahrenheit are given in the following table:

B. & S. G.	$2r$.	d.	D'.
20	.03196	.0050	350×10^{-10}
15	.05706	.0100	300×10^{-10}
10	.10189	.0180	275×10^{-10}
8	.12849	.0220	258×10^{-10}
6	.16202	.0350	200×10^{-10}
4	.20421	.0700	171×10^{-10}
2	.25763	.0700	170×10^{-10}
Measurements upon conductors of larger sizes to the limit of a diameter of 0.625 inch.	.625	.0700	170×10^{-10}

The experiments demonstrated that the voltage at which the atmospheric line loss is inaugurated varies as the atmospheric density; *i. e.*, directly as the barometric pressure and inversely as the absolute temperature. On substitution of corresponding values obtained by experiment, equation (10) takes the following practical form:

$$E_{max} = \frac{17.94b}{459. + t} \times 2055 \log_{10} \left(\frac{s}{r}\right) D' (r + d) \times 10^{10} \qquad (12)$$

wherein

b = the barometric pressure in inches of mercury.

t = the temperature in degrees Fahrenheit.

Since the value of d and D' are constant for diameters of conductors larger than 0.250 inch, it follows that equation (12) for corresponding conductors reduces to

$$E_{max} = \frac{17.94\ b}{459 + t} \times 350{,}000 \log_{10} \left(\frac{s}{r}\right)(r + 0.07) \qquad (13)$$

The results obtained by calculation employing equations (12) and (13) are compared with the measurements made by Mershon on the Telluride high-altitude line in 1898 and those obtained by Professor Harold B. Smith upon the Worcester Polytechnic Institute laboratory line in 1901 and 1902 at ordinary altitudes.

Efforts were made to determine the effects of the presence of moisture upon the point at which the atmosphere about high-voltage lines becomes conductive; *i. e.*, upon the point at which the sudden rise in the loss-curve occurs. However, no definite effect of this sort could be found, and this is practically in accord with Mershon's conclusions after his observations made upon the Telluride line under variable weather conditions. If there is such an effect it must be small.

The following table of values has been calculated by means of equations (12) and (13). It shows the corresponding diameters of line conductors that must be employed to avoid loss between wires for a series of line voltages wherein the barometric pressure is 29.5 inches of mercury, the temperature seventy degrees Fahrenheit, and the distance between the conductors forty-eight inches.

Maximum volts at which atmospheric conduction loss occurs.	Corresponding effective volts (sine wave)	Operating pressure, 90 per cent of corresponding effective volts.	Diameters of conductors in inches.
78,500	55,000	50,000	0.058
118,000	83,300	75,000	0.106
157,000	111,100	100,000	0.192
235,500	166,600	150,000	0.430
314,000	222,200	200,000	0.710
392,000	277,700	250,000	0.990

The real voltage limit to-day in transmission is due to the insulator, where the line has to be exposed to the weather. In the future the insulator difficulty will be solved in one way or another and higher voltages will be used. Possibly in large undertakings the line may be protected from the elements by means of a continuous covering. It is evident that when such high voltages are employed atmospheric conduction, or "the brush" (as one experienced high-voltage engineer termed it in conversation with the writer), must be avoided. High-voltage brush discharge was studied and reported upon in the A. I. E. E. Transactions by Dr. Steinmetz.[1] He applied to it the term corona. The present paper shows that the brush discharge or corona occurs always when a definite strain exists in the atmosphere next to the high-voltage conductors, and that to avoid such corona with its destructiveness and waste of power it is necessary on transmission lines and auxiliaries to proportion things so as to keep the dielectric strain of the atmosphere below a definite point above which the corona will inevitably develop.

In the above table a factor of safety of 1.11, or a margin of ten per cent, has been allowed in estimating the safe voltage at which to operate so as to avoid losses due to brush discharge. This is a laboratory

[1] Transactions A. I. E. E., vol. x, p. 85, 1893.

conclusion only. In application the following points must be kept in mind:

1. Without special care there will be doubt in advance as to the exact value that the voltage-wave will not exceed. Almost invariably the line-charging current will cause important line-voltage wave-distortion, so that the maximum of the wave will exceed the effective value of the voltage by a factor much greater than the square root of two. The corona formation depends primarily upon the maximum and not upon the effective value of the wave; this has been found by Scott, Mershon and others, as well as in the present experiments.

2. One must remember that unless the insulators are properly proportioned, after the cross-arms and pins have been exposed to the weather for some time and have become conductive, the presence of the insulators made of material that has a considerably greater permeability to dielectric flux (greater specific inductive capacity) than the atmosphere, will cause corona to a greater or less degree to form over the conductors in their neighborhood, even if the line has been proportioned so as to avoid corona or atmospheric conduction over the remaining portion of the conductors. The presence of corona upon the conductors in the neighborhood of the insulators will likely be accompanied by corona over the pins inside the insulators, resulting in their ultimate injury if made of wood from this cause alone, even if the surface leakage current is so limited as not to injure the pin.[1]

In view of the above it is evident that practical experience and not the laboratory must eventually determine the factor of safety that should be allowed under given circumstances in lieu of the 1.11 factor or the ten per cent margin allowed in the above table.

The paper closes with the suggestion that when viewed in the dark the corona formed upon wires of given diameters and distances apart provides a method for gauging high voltages that is free from the short-circuit and surging disturbances occasioned by the use of the spark-discharge method. Either two parallel conductors or a conductor mounted at the centre of a cylinder may be employed for this purpose.

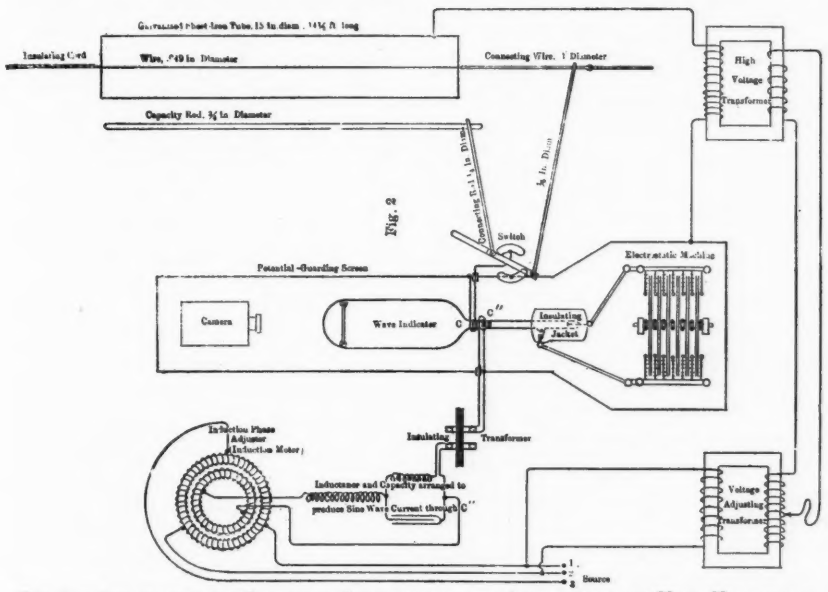


FIG. 2.—APPARATUS FOR STUDYING CONDUCTIVITY OF ATMOSPHERE AT HIGH VOLTAGES.

FORMER STUDIES OF ATMOSPHERIC CONDUCTION.

The atmosphere is ordinarily the general medium in which electric circuits and apparatus are immersed. It is depended upon to a greater extent for insulation than any other medium or material.

Its dielectric strength to resist disruption by electric forces, in bulk, under ordinary conditions as to temperature, barometric pressure and entrained moisture, from an engineering point of view, has been the subject of extensive and critical investigation by Steinmetz, whose results have been communicated to the Institute in several papers.

Steinmetz found in his studies of the electric disruptive strength of the powerful solid dielectrics that the atmosphere surrounding the solid dielectric specimen and the electrodes applied thereto would break under the strain formed by the flux of electric force through it much more readily than the solid dielectric. This gives rise to envelopes of conductive atmosphere located around the electrodes and over the surfaces of the powerful dielectrics. This phenomenon, which has the appearance of the familiar brush discharges so easily obtainable in electrostatic experiments, was studied at some length and he applied to it the term corona.

Scott subsequently investigated experimentally the conditions under which the atmosphere in close proximity to high-voltage lines is subjected to electric stresses that bring it to the breaking point, causing the formation of brush discharges accompanied by losses of power in measurable amounts. Mershon, supplementing the work of Scott, carried out a series of experiments at Telluride, Col., in which losses between wires due to high voltage were measured on a line 2.25 miles long, whereon the conductors having a diameter of 0.162 inch were mounted at various distances apart and between which pressures varying from 20,000 to 60,000 volts were applied. The results obtained through this series of investigations by Scott and his coworkers were reported by him to the Institute in a paper at the June meeting in 1898.

The characteristic phenomena of greatest interest to the engineer, as brought out in this classic paper, are those to which the Telluride curves of voltage and line loss apply and which are charted in Fig. 6, vol. xv, p. 545, as determined by Mershon and which for convenience is reproduced as Fig. 1 of the present paper.

The experimental and analytical study upon which this paper is based was undertaken for the purpose of securing further knowledge of the nature of the line loss as observed by the above gentlemen.

THE ELECTROSTATIC FIELD.

When the terminal faces of a dielectric are in contact with conductors between which an electromotive force is applied, an electric force is exerted throughout the dielectric in variable degree, according to the position with reference to conductors. This electric force produces a distortion of the atomic structure of the dielectric; *i. e.*, a displacement of the electrons forming the dielectric atoms. Such electron displacement, while in progress, constitutes an electric current. The displacement encounters the reaction due to internal atomic forces which tend to maintain the original structural form. This reaction is the cause of the formation of the familiar counter-electromotive

[1] "Burning of Wooden Pins on High-Tension Transmission Lines," by C. C. Chesney, Transactions A.I.E.E., vol. xx, p. 435, March 22, 1903.

force of a condenser and is in proportion to the total amount of electricity or the time-integral of the current that was passed through the dielectric. When the process of atomic distortion proceeds beyond the point of structural rupture, the ordinary conduction current ensues. Thus through a dielectric prior to the rupturing point the only current that can be passed is a displacement current. The passage of such displacement current and the establishment of the corresponding field of electrostatic force are merely cause and effect in one and the same operation. In any portion of the dielectric the value of the strength of the electrostatic field of force therein established is proportional to the displacement of electricity; *i. e.,* to the time-integral of the displacement current that accompanied the establishment of such electrostatic field. For engineering purposes, therefore, the time-integral of displacement current may be conveniently employed as a measure of the strength of the corresponding electrostatic field of force.

The energy that is taken up in the formation of an electrostatic field of force per unit dielectric volume and which has been applied, therefore, in the passage of the corresponding time-integral of displacement current is

$$J = \tfrac{1}{2} CE^2 \qquad (1)$$

where C is the capacitv in farads; *i. e.,* the coulombs of displacement current per volt.

When an electromotive force of one volt is applied to the opposite faces of a centimetre cube of air at ordinary barometric pressure and temperature, the energy taken up by the electrostatic field formed thereby throughout the cube, will be

$$441.7 \times 10^{-10} \text{ joules}$$

No important change in this value occurs with variation of barometric pressure and temperature. When it is substituted in equation (1) the corresponding strength of electrostatic field thus produced per volt per centimetre of air expressed in coulombs of displacement current per square centimetre is found to be

$$C = 883.4 \times 10^{-10} \qquad (2)$$

For present convenience strength of electrostatic field of force will be referred to as density of dielectric flux. It may, therefore, be stated with reference to the dielectric permeability of air that, one volt applied through a distance of one centimetre in air will establish a dielectric flux density of 883.4×10^{-10} coulombs per square centimetre.

This is the same thing as the capacity in farads of a condenser having surfaced electrodes of one square centimetre each, facing opposite sides of a centimetre cube of air.

In this method of designation it follows that the density of dielectric flux established per volt per unit area of conductor terminal face is equal to the capacity in farads per unit area of such face. Thus in connection with a transmission line the total dielectric flux set up between conductors per unit length will be the product of the capacity of such unit length of line in farads and the applied electromotive force. The corresponding density of dielectric flux extending from the surface of either conductor is the total flux per unit length divided by the corresponding conductor surface.

ANALYTICAL STUDY OF MERSHON'S RESULTS.

From the work of Steinmetz it is known that

a. The atmosphere and the gases generally, conduct after disruption in two forms:

1. Arcs or very hot streamers. A concentrated conduction at high current-density.

2. Corona or brush discharge. A diffused conduction at low current-density, developing heat at lower intensity.

b. 1. The dielectric strength of the atmosphere in bulk is such as to require for rupture approximately a pressure gradient of 10,000 sine wave effective volts per inch.

2. The thin zones of atmosphere that enclose the electrode and which are in immediate contact therewith have a far greater dielectric strength than air in bulk, corresponding to a ratio of dielectric strengths of from five to ten.

From the nature of sparking discharges through air the conclusion is reasonable that whenever the flux of electric force, or more briefly the dielectric flux, through the air in a given state as to temperature, pressure and freedom from foreign material, rises to a certain value an atomic structural rupture of the air will occur, resulting in conduction.

From Steinmetz's results it is evident that this maximum value of dielectric flux-density at which atmospheric disruption will not occur will depend upon the position of the particular portion of the atmosphere being considered relative to the conductors or electrodes between which the high voltage is applied.

The classic electrostatic experiments as well as the modern Paschen's law,[1] which has been tested to above five atmospheres and which asserts that the sparking discharge voltage through given distances in air increases with the atmospheric density and, therefore, as the pressure and inversely as the temperature on the absolute scale, make it reasonable to conclude that the minimum dielectric flux density that will cause atmospheric conduction will vary as the atmospheric density and therefore directly as the barometric pressure and inversely as the temperature on the absolute scale.

The researches of Hittorf, Crookes, J. J. Thomson and others, including some recent work upon this particular point by Dr. Blaker, make it reasonable to conclude that so far as concerns magnitudes which are appreciable in engineering, the atmosphere under ordinary conditions and fairly clean, *i. e.,* free from floating conducting material, will not conduct appreciably in the neighborhood of high-voltage lines when their surfaces are bare, so long as no portion of such atmosphere is permeated with a dielectric flux that is not sufficient to cause rupture at any one point. When the dielectric flux exceeds the rupturing point, conductivity ensues and there is a conductive transfer of current from conductor to conductor through the atmosphere.

On continuous-current circuits the amount of transfer of such current must be small prior to the application of a voltage sufficient to break entirely through the dielectric atmosphere from conductor to conductor, when the familiar arcing discharge occurs, amounting in an engineering equipment to a short-circuit.

On alternating-current circuits, as long as none of the atmosphere in the neighborhood of high-voltage conductors is ruptured, transfer will occur only of capacity charging current which is in leading quadrature with the voltage. However, as soon as the zones of atmosphere immediately surrounding the conductors are subjected to a dielectric flux exceeding the rupturing point, such zones become conductive, thereby doing two things:

1. The effective diameter of the conductor is increased by the presence of the conducting zone, thereby increasing the capacity of the line and consequently the charging current.

2. The presence of the conducting zone must act in effect to place a high resistance in series with the line current which the charging current must traverse. This must produce a lag in the charging current causing it to have a power component in phase with the voltage. In effect such action is the same as though the power

[1] "Conductivity of Electricity through Gases," J. J Thomson, edition of 1903, p. 367.

component of the current were conductively transferred through the atmosphere.

Where the conductors of a high-voltage transmission line are separated a distance between centres of more than twenty diameters, the dielectric flux passes from the surface of a conductor of round section at a density that is so nearly uniform about the circumference that it may for practical purposes, in the present instance, be assumed constant. In discussing these relations further the following symbols will be used:

C, the capacity of the line in farads per inch of length.

s, the distance between the conductors in inches.

r, the radius of the conductors in inches.

ϕ_0, the total dielectric flux established from conductor to conductor, measured in terms of the corresponding displacement current; *i. e.*, in coulombs.

D_0, the dielectric flux-density at the surface of the conductor in coulombs per square inch of sectional area.

D^1, the corresponding dielectric flux-density at a distance slightly remote from the surface of the conductor, where the extraordinary dielectric strength of the atmospheric zone ceases and where occurs the region of greatest dielectric strain relative to the disruptive strength.

D, the corresponding dielectric flux density at any point.

The capacity between wires in farads per inch of line is

$$C = \frac{0.00306}{\log_{10}\left[\frac{s}{r}\right]} \times 10^{-10} * \qquad (3)$$

The total displacement current and, therefore, the total dielectric flux established between conductors per inch of line at the line voltage E is

$$\phi_0 = E\,C = \frac{0.00306}{\log_{10}\left[\frac{s}{r}\right]} \times E \times 10^{-10} \qquad (4)$$

The dielectric flux density at the surface of the conductor is

$$D_0 = \frac{\phi_0}{2\pi r} \qquad (5)$$

$$D_0 = \frac{0.00306}{2\pi r \log_{10}\left[\frac{s}{r}\right]} \times E \times 10^{-10} \qquad (6)$$

At a radial distance d from the surface of the conductor, the corresponding dielectric flux density is

$$D' = \frac{\phi_0}{2\pi(r+d)} \qquad (7)$$

$$D' = \frac{0.00306}{2\pi(r+d)\log_{10}\left[\frac{s}{r}\right]} \times E \times 10^{-10} \qquad (8)$$

* Perrine and Baum, Trans., A. I. E. E., vol. xvii., p. 362, May 18, 1900.

In alternating-current work the maximum values of D_0 and D' are wanted, and the maximum values of the voltage waves must, therefore, be used for E, as reduced from equations (7) and (8), thus:

$$E_{max} = 2055 \log_{10} \cdot \left[\frac{s}{r}\right] \cdot r \,.\, D_0 \times 10^{-10} \qquad (9)$$

$$E_{max} = 2055 \log_{10} \cdot \left[\frac{s}{r}\right] (+ d)\, D' \times 10^{-10} \qquad (10)$$

When Mershon's results given in Fig. 1 were used to test these equations it was found that they correctly accounted for the relation between the separation of the conductors and the voltage at which the initial brush discharge took place. These results gave also a certain value for D_0 which would not give correct results when used to determine the voltage required to start the line loss for the small wires used by Scott in some of his experiments at Pittsburg.

At this point a rough laboratory test was made to see whether one would find the start of the loss between wires to occur at the same voltages for the same size of conductor and distance apart that Mershon found. The results obtained were totally different. It became evident from this disagreement that barometric and temperature variations exerted important influences. The difference between the approximate results obtained by the author and those of Mershon indicated that the voltage starting the loss between wires would vary as the barometric pressure. When, however, the values deduced from the Telluride results were correspondingly corrected for barometric pressure and applied as constants in these equations the voltages observed by Scott for starting the loss on small wires were in no wise predicted. Upon thinking over the probable causes for this, it seemed that the reasons were most likely as follows:

The dielectrically powerful atmospheric film surrounding the small wire would cause the initial rupture to occur at a distance from the surface of the conductor entirely appreciable with respect to the radius of the conductor, in which event some value of D′ different from D_0 would be responsible for the initial rupture of the atmosphere. The value of D′ would be indeterminate so long as we have no means for determining the distance from the surface of the conductor at which the initial rupture occurs. Again, it was apparent that the values of D′ and the distances at which they occur from the surface of the conductor might vary in an unknown manner relative to the radius of curvature of the conductor.

It became evident that a series of experiments would be necessary in order to obtain all of the data required to write properly the formulæ expressing the relation of all the factors that control the start of the atmospheric loss between wires.

It was determined first of all to check by experiment the impression gained from the observations of Scott that the visual appearance of the corona or brush discharge on the wire occurs simultaneously with the initial formation of energy loss, as the line voltage is raised; and to observe the nature of the charging current with respect to the line voltage with a view to determining more data regarding the origin of the loss. Should the start of the loss be accompanied simultaneously by the visual appearance of the corona over the wire, this would be an easily discernible fact that would greatly facilitate subsequent experimental work. The point at which the atmospheric conduction loss would occur in relation to diameters of conductors, their distance apart, applied voltage, barometric pressure, temperature, moisture, and the thickness of the dielectrically powerful but thin zones of atmosphere could then be noted simply by watching for the appearance of the corona.

For this purpose it was realized that the most convenient and effective laboratory arrangement of the line would be to suspend a single wire for observation at the centre of a metallic tube of suitable diameter much the same as originally suggested by Mershon. There are three evident advantages which this arrangement has in laboratory work of this character over the use of a pair of parallel wires.

1. The dielectric flux established about the wire between it and the cylinder is easily and exactly estimated in terms of the dimensions of the wire and cylinder and the dielectric flux-constant or specific inductive capacity of the atmosphere. The flux emanates uniformly from the wire, thus making definite the results deduced from observations.

2. A lower voltage suffices to cover a given range of experimental study.

3. The tube may easily be made to contain atmosphere at various pressures, temperatures, and degrees of entrained moisture.

At this stage of the work in April, 1903, Mr. Ford, a senior student in my class, assisted by Mr. Wernicke, undertook as a thesis to make the experiments. The author is greatly indebted to these young men for the energetic and effective manner in which they did the work.

They erected apparatus, determined and charted results as follows:

The general plan for observing the details of the corona and loss phenomena due to high voltages with the aid of a cathode-ray wave indicator is given in Fig. 2. A brass wire 0.049 inch in diameter was mounted at the centre of a galvanized sheet-iron tube fifteen inches in diameter and 14.5 feet long, as shown. Between this wire and the tube high pressure was applied and adjusted to any desired value up to 80,000 effective volts by means of the transformers, as shown.

The arrangement permitted the coils C′ of the wave indicator to be inserted by means of a switch, as shown, in series with the wire so as to indicate whenever desired the charging current set up from the wire to the cylinder. In order to note at a glance any departure of the wire charging-current form from the charging-current form that should exist if no atmospheric conduction were present, a 0.75-inch brass rod with well-rounded ends was placed outside the cylinder and connected through the switch to the same terminal of the transformer as the wire. The arrangement was such as to permit quickly the switching of the indicator coil C′, in series either with the wire or rod. Then at low voltages, prior to the disruption of the atmosphere about the wire, the indicator diagram produced by the wire and rod-charging currents were adjusted to equality by moving the rod in its position relative to the cylinder.

A sine wave current controlled by a proper circuit of inductances and capacity and passed through C″ produced the known indicator motion.

In the use of high voltages in this manner two precautions must be taken in the use of the wave indicator. It must be entirely enclosed in a potential-guarding screen set up on high-voltage insulators and a connection must be made from the screen to the terminal of the transformer that is connected to the wire and capacity rod. The sine wave current must pass through an insulating transformer and the secondary must be connected to the guard screen so as to protect the low-voltage source and relieve the indicator of electric stress at all points.

A three-phase source was employed so as to draw for convenience the sine wave current through an induction phase adjuster, as shown. By shifting the sine wave, any intricate part of the unknown wave was made to occur when the sine wave was passing through zero and, therefore, changing most rapidly, thus unfolding the intricate portion of the unknown wave so as to be observed and recorded to best advantage.

(To be concluded.)

BOOK REVIEWS.

"The Localization of Faults." Second edition. F. Charles Raphael. New York. D. Van Nostrand Company. Cloth. 205 pages. 6 by 8½ inches. 112 figures and diagrams. Supplied by the ELECTRICAL REVIEW at $3.

In preparing the second edition of this well-known book on the localization of faults in electrical conductors, the first edition has been considerably enlarged and added to, and the matter brought up to date. This has been made necessary by the progress made in the art of cable-making and laying, and the increased practice and experience in testing. The work is quite complete, and is written in such a way as to be useful to the practical man, as well as the expert. The analytical proofs of all the laws are brought together in one chapter, leaving the main text of the book unencumbered with mathematics. The methods given include direct measurements and induction methods. In each case the apparatus necessary for doing the work is explained and a formula given for locating the breakdown.

"Leçons d'Electrotechnique Générale." Second edition. P. Janet. Paris. Librairie Gauthier-Villars. Paper. 369 pages. 6½ by 10 inches. 166 figures. Supplied by the ELECTRICAL REVIEW at $3.

This is the second edition of the first volume by the distinguished professor of the Faculté des Sciences de l'Université de Paris, and directeur du Laboratoire Central et de l'École Superieure l'Électricité. It treats of the general laws of electrical conduction and continuous currents, and has been revised and enlarged, the subject being handled in the author's usual clear style.

"Cassell's Popular Science." Edited by Alexander S. Galt. New York. Cassell & Company, Limited. Cloth. 576 pages. 8 by 10¼ inches. Profusely illustrated, including a number of colored plates. Supplied by the ELECTRICAL REVIEW at $5.

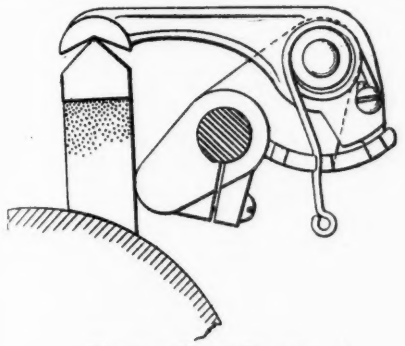
This book is a compilation of a large number of interesting articles written in a popular style by authors well informed in their subjects. The illustrations are good and the subjects are taken from natural and physical sciences. There are several articles on electrical subjects, which should give the layman an accurate idea of certain electrical processes and applications.

"Electric Traction." John Hall Rider. London, Whittaker & Company. New York, the Macmillan Company. Cloth. 454 pages. 5 by 7½ inches. 194 illustrations. Supplied by the ELECTRICAL REVIEW at $3.

This is another attempt to produce a satisfactory book on electric traction, for which there is an undoubted need, though the art is advancing so rapidly that any work prepared to-day is soon out of date. The present work is broad and comprehensive, treating in minute detail of various subjects. A large part of the reading matter is quite obvious, however, and hardly seems to deserve the space given to it. For instance, in the chapter on overhead systems, the author states that it is impossible to erect overhead conductors suitable for tramway work without making them apparent to the passer-by. The reviewer was at first inclined to take exception to this, but subsequent investigations seem to bear out the above statement, the accuracy of which he now cheerfully concedes. At some points the author's conclusions may be criticised. Thus, under the head of distribution, the statement is made in reference to variations in line potential, "the variations in pressure should certainly be kept within ten per cent, say five per cent up and down from the normal." This is certainly an ideal condition of operation. But, aside from the fact that the real object of a railway is to pay dividends, we doubt the ability of sordid railway managers to see the advantages of expending the additional pounds of money required to erect the additional tons of conductors necessary to keep the pressure within the prescribed limitations of five per cent up and down from normal. The chapter on accummulators is as interesting as it is inaccurate. It is pointed out that the positive plate, on beginning charge, changes from lead sulphate to lead oxide, then to lead peroxide. The negative changes directly from lead sulphate to pure lead, without taking the trouble to pass through this intermediate stage. And the electrolyte changes from water to sulphuric acid. Viewing these changes, the author comes to the conclusion that "the sulphuric acid in the liquid acts only as a conductor and takes no part in the reactions." More data on such an erratic lead cell would be of interest. In the introduction the following is given to the reader: "Experience has shown that a car can be propelled at an average speed of about eight miles per hour on moderately easy roads, with an expenditure of energy equal to about one Board of Trade unit." No mention is made of the weight, although hitherto this factor has given more or less trouble by obtruding itself into such computations. Although the book gives an interesting review of electric traction, it is scarcely an important addition to the literature on the subject.

Electrical Patents.

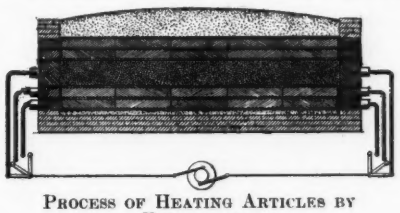
Mr. De Witt C. Cookingham, of Cleveland, Ohio, has assigned to Mr. John H. Hertner, of the same place, a one-half interest in a patent recently obtained by him on an electric brush-holder. The object of the invention is to provide a simple and efficient device for holding an electric brush against the surface of a movable commutator. In the embodiment of the invention a commutator is employed and also a fixed stud or rod to which the brush-holder is adjustably fixed. The contact devices include a brush made of carbon, and a brush-holder which includes a fixed member and a movable spring-actuated pressure arm. The fixed member has a split sleeve which embraces the fixed rod and is adjustably clamped thereon. This member has also a finger with a broad rounded end, which occupies a position as close as possible to the commutator. The arm is pivoted to the fixed member. This connection is effected by means of a stud, which is integral with the member and a sleeve which is part of the arm, which embraces this stud, the



Electric Brush-Holder.

arm lying upon the thin upper end of the fixed member. The brush has its lower end inclined on an arc which fits the surface of the commutator. The front face of the brush bears against the finger, and the outer end of the arm bears down upon the upper end of the brush and holds it always in contact with the commutator. The upper end of the brush and the under surface of the upper end of the arm have, respectively, a projection and a recess which receives it. In the preferred construction, there is an angular recess in the underside of the arm, and the brush has an angular projection at its upper end which enters this recess. The inclination of the engaging surface of the brush and commutator, together with the downward pressure upon the brush from the arm, causes the brush to press against the finger. Their action, coupled with the fact that the upper end of the brush is prevented from turning on said finger as a fulcrum by the engagement of the projection in the recess, holds the brush in substantially one position relative to the commutator. Of course, as the lower end of the brush wears away, the upper end of the brush will swing a little on the finger, but any greater movement is prevented by the described construction.

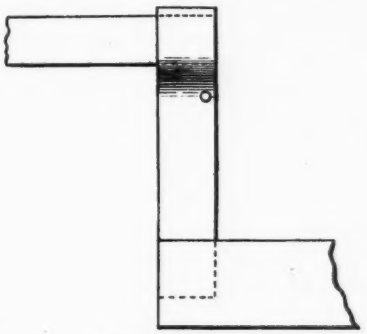
A process of heating articles by electricity has been invented by Mr. Edgar F. Price, of Niagara Falls, N. Y., and



Process of Heating Articles by Electricity.

the patent obtained thereon has been assigned to the Union Carbide Company, of the same place. The furnace used is a rectangular structure having side and end walls and a hearth of refractory non-conducting material. A group of electrodes extends through each end wall of the furnace. These electrodes are preferably of carbon and may be concentrically arranged, and have a layer of insulating material interposed between the ones adjacent. The electrodes have terminals shown as metal plugs screwed into them. Switches are employed to deliver electric current from any suitable generator, such as a dynamo, to the corresponding electrodes at each end of the furnace. The articles to be baked are placed on the hearth and along the side walls of the furnace, being preferably separated from each other and surrounded by a filling or packing of suitable refractory non-conducting or other material. The bars are preferably arranged in two or more concentric layers. A resistance core which is arranged centrally within the rows of bars to be heated is entirely enclosed by them. A loose filling of granular material is placed between the hearth and side walls and the charge, and also overlies the charge and closes the top of the furnace. An electric current is then passed through both the resistance core and the carbon bars or other articles to be heated. The heating is preferably effected by first passing the whole or a major portion of the electric current through the central core, which soon becomes heated to incandescence. The articles which lie next to the core will thereby be heated to a fairly high temperature, but not uniformly throughout, while the articles which lie at some distance from the core will be heated to a much lower temperature. The switches are thereupon shifted to divert a whole or a portion of the electric current from the central core to certain of the electrodes and thence through the articles lying between them. These articles are thereby uniformly heated to a desired temperature. The switches are then again shifted to pass the whole or a major portion of the current to other of the electrodes and thence through the articles lying between them. These articles are thus heated to the desired temperature. The switches are then again shifted to pass the whole or a major portion of the current to the remaining electrodes and through the articles lying between them and which have been subjected to the lowest temperature, thereby finishing the heating operation. Of course, furnaces different from the one described may be employed, if desired.

Commutator leads and the mode of making these are the subject matter of a patent recently granted to Mr. Charles F. Adams, of Pittsfield, Mass., who has assigned his entire interest in the patent to the Stanley



Commutator Lead.

Electric Manufacturing Company, of the same place. In the embodiment of the invention, the commutator lead is set into a slot in a commutator-bar, and an armature conductor is fitted into the forked end of the commutator lead. The method of forming the lead is as follows: the lead is stamped out of sheet copper or other conducting material and a slit is cut part way down the median line. The sheet is also bent near the bottom of the slit. The sheet is then folded over on the median line and the two parts fastened together in any suitable manner. The stamping out of the lead and the slitting of the end may be performed in a single operation, and then by folding over and pressing together the lead is completely formed. In a modified form of this invention, a bead or rib is left on the edge of the lead for the sake of lateral stiffness. The process of stamping and folding is the same as has already been described, the bead or rib being formed in the stamping operation. It is not essential that the transverse bend at the bottom of the slit should be formed when the lead is stamped out. This bend may be formed after the strip is folded over.

The American Institute of Electrical Engineers.

Important Papers on the Conductivity of the Atmosphere at High Voltages, and European Practice in the Construction of High-Tension Lines, Read at the 184th Meeting.

AT THE 184th meeting of the American Institute of Electrical Engineers, held in New York city, February 26, at the Chemists' Club, 108 West Fifty-fifth street, two exceptionally interesting and important papers were read and discussed. The first is by Professor Harris J. Ryan, of Sibley College, Cornell University, and is entitled "The Conductivity of the Atmosphere at High Voltages." This paper, which appears on another page of this issue, gives an analysis of the factors which are responsible for the atmospheric loss occurring in high-voltage lines.

Professor Ryan sketched briefly previous researches into this field, described the method adopted in the present investigation, and gave a formula which expresses the relation between the voltage, conductor sizes, distance of separation and atmospheric conditions, and the maximum value of the voltage wave applied to the line which brings about the loss. The results, computed by means of this formula, show excellent agreement with those obtained in practice.

The discussion of this paper was opened by Mr. C. F. Scott, of Pittsburg, Pa., who spoke briefly of the development of high-voltage transmission and the new problems encountered at every increase in the line pressure. Professor Ryan's paper deals with something beyond present conditions, but these conditions are now being approached. The results of the investigation are therefore of great commercial value, as well as of scientific interest. Mr. Scott gave an interesting account of the early investigations conducted at Pittsburg, which were conducted on what would be a small scale to-day, and in which three phenomena were observed —noise, light and the formation of ozone, all indicating a line loss which, in that case, was not measurable. This work was followed by Mr. R. D. Mershon's experiments at Telluride on a large scale, where the losses were measured; and this, again, has been followed by the rigorous investigation of Professor Ryan of the corona losses.

Mr. Scott read a communication from Mr. S. M. Kintner, of Allegheny, Pa., calling attention to Mr. Marconi's experience, that transmission of wireless telegraph messages takes place better at night than in daytime. Attention was also called to the effect of temperature on line losses. It is not impossible that there might be an appreciable difference in transmission efficiency in summer and winter. The paper suggested that, where the spark-gap is used to measure high voltages, the needles be replaced by round or bull-nose points, as these were thought to give more reliable results.

A communication from Mr. P. M. Lincoln, Pittsburg, Pa., was also read by Mr. Scott, which dwelt upon three points suggested by Professor Ryan's paper and of interest to every engineer. The first was the question whether the corona losses take place to any extent to-day; the second, at what voltage will they begin to be serious, and the third, what methods are available to prevent them. The limits at which these losses begin are beyond the practice of to-day, but they are being approached. It is pointed out that a layer of rubber insulation over the wire effectively prevents the corona discharge, which indicates that atmospheric losses are taking place.

Dr. Samuel Sheldon, of Brooklyn, described the four types of conduction through air. These are the glow, the brush, the spark and the arc. The glow discharge is of pink-violet color, of velvet appearance, is silent, the discharge is apparently continuous, the dielectric field strength at which it begins has a minimum value, and there is a preference as to polarity. The discharge takes place at a lower voltage when the needle point is positive as opposed to the ball, than when the needle is negative. The brush discharge is blue-violet in color, hisses, is probably intermittent, takes place at a definite potential, and has also a polar preference. The spark discharge is white and participates in the coloring of the vapor of the electrodes. It is probably oscillatory. In the arc a column of luminous gases is formed, the color of which depends upon the character of the electrodes. Dr. Sheldon believes that the corona is probably a combination of both the brush discharge and the glow. This is indicated by the color and the noise, as well as by the curves shown by Professor Ryan. The glow starts at a voltage ten to fifteen per cent less than the spark discharge. The speaker closed with the suggestion that instead of determining high voltages by means of a corona observed around a wire placed in the dark, the brush discharge between two needle points might be adopted, if this takes place at a perfectly definite voltage. This would avoid short-circuiting the air-gap —a disadvantage of the spark method of measuring voltages, but the voltage at which the discharge becomes apparent should be redetermined.

Professor Harold B. Smith, of Worcester, Mass., described the development of the electrometer which is in use in his laboratory for measuring voltages up to 400,000. He had at first attempted to use an ordinary electrometer, but found this unreliable at high potentials, due probably to the repulsive effect of high voltages overcoming the attractive effect of differences in potential. He had therefore adopted the repulsive effect, and found this entirely reliable as well as more convenient than the other.

Mr. Percy H. Thomas, of Pittsburg, Pa., raised a number of questions as to what is actually taking place within the corona, and wished to know whether any study had yet been made as to the effect of electrode materials. In any discharge through a vapor, three effects are to be reckoned with—the resistance of the vapor, and the forces required to cause the current to leave one electrode and to enter the other. The latter two vary with the electrode material. Mr. Thomas had made measurements of the line loss of a 100-mile 50,000-volt system. The losses were measurable, being about ten kilowatts. The voltages agreed with Professor Ryan's equation.

Professor Ryan said that what actually took place in the corona was not known, though there is probably an ionization of the air, the free ions traveling out through the air from the wire during one half cycle and returning during the next. With very low frequencies it is possible there might be a continuous discharge. With continuous currents, and using small wires, it is possible to pass a measurable current through an extremely long air-gap. As yet no investigations had been made of the effect of electrode materials. Iron and copper had been used, but no difference was noticed. Aluminum had not been tried, this being the metal which Mr. Thomas said would show marked differences.

Mr. J. W. Lieb, Jr., New York city, then read a paper contributed by Signor Guido Semenza, entitled "European Practice in the Construction and Operation of

High-Pressure Transmission Lines and Insulators," an abstract of which will be published in the ELECTRICAL REVIEW. This paper describes the line construction methods used in Italy, and lays emphasis upon the desirability of accurate calculations for pole construction and location. The paper was followed by an illustrated description by Mr Lieb of Italian power plants.

In the discussion, attention was called to the difference between European and American methods, as regards line construction, the general opinion seeming to be that, in this branch of the art, we are considerably behind and have not given the matter sufficient attention. The European method of construction is, however, being studied in this country, and, indeed, used in a few cases.

President Arnold called attention to a certain Mexican line, where seven poles are being used to the mile, these poles being practically steel windmill towers. He said, further, that the New York Central had decided to put its lines overhead wherever possible, and would use iron poles. This construction was decided upon because it was thought to be more reliable, as it permits any fault to be located and repaired at once.

Mr. W. S. Dix, New York city, said that the European practice in insulator design had been adopted for the new Shawinigan Falls transmission system. The insulators will have three petticoats, widely separated.

Others present referred to the different conditions obtaining in Europe and in this country, and the difference which has existed in the methods of designing machinery and stations and line work.

A vote of thanks was then tendered to Professor Ryan and Signor Semenza, after which the meeting adjourned.

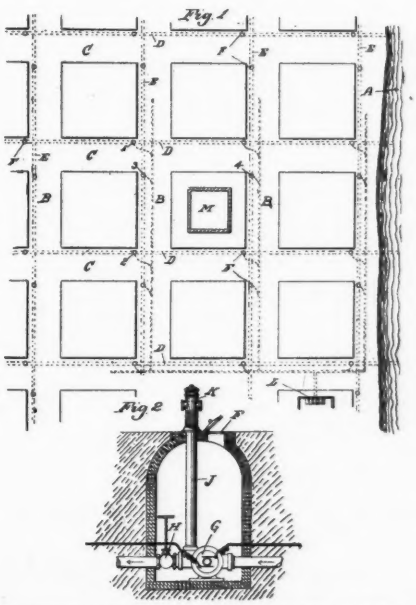
Cincinnati Chapter American Institute of Electrical Engineers.

The Cincinnati chapter met on February 15 at the Grand Hotel. A dinner was served to the fifty-three members and visitors, after which they adjourned to the spacious auditorium of the hotel. Mr. W. A. Blanck, of the Arnold Electric Power Station Company, read a most interesting paper on a timely topic, *viz.*, "Single-Phase Railroads." After outlining the various systems which have been tried, first, the synchronous motor driving a generator mounted on the train; second, the induction motor, as a subdivision of this, the Arnold system of induction motor and air compressor combined; third, the alternating-current series motor; fourth, the repulsion induction motor as developed by Steinmetz and Schuler, and, last, the repulsion series motor of the Union Electric Company, of Berlin. Mr. Blanck took up the subject of controllers, car wiring, trolley bow and line construction. He then took a typical sixty-mile road equipped both by the present system of alternating-current generator with rotary converter, substations and what he termed the alternating-current system, using transformer substations and 3,000 volts on the trolley line. Comparing item for item, he showed that the direct-current system, giving the same service as a single-phase system, cost thirty-two per cent more than the alternating-current system.

The paper was thoroughly discussed. At its next meeting the chapter hopes to have a paper on another timely topic, "Steam Turbines."

An Electrically Operated Auxiliary Water Supply System.

The visitation of two important cities by disastrous conflagrations within very recent dates has impressed upon municipal authorities the value of a large supply of water ready for any emergency. Where a city is situated near to or contiguous with a large natural body of water, the problem of supplying a comparatively inexhaustible amount is easy, under modern engineering conditions. There is possible a large central pumping station, with properly distributed reservoirs, or there can be local pumping units serving particular localities.



ELECTRICALLY OPERATED AUXILIARY WATER SUPPLY SYSTEM.

During the past few weeks there has been considerable agitation in New York city in favor of the use of salt-water mains, making possible the utilization of the North and East rivers in cases of emergency. In connection with this problem of using salt-water mains for fire-fighting and other purposes, Mr. Oliver T. Hungerford, president of the Hungerford Electric and Manufacturing Company, New York city, has devised a water supply system which is possessed of several points of great merit. The accompanying illustration shows diagrammatically the principal features of this system, which, while simple in their characteristics, make possible a wide range of service and a great flexibility of installation.

The system consists essentially of a series of salt-water mains—running east and west in the case of the borough of Manhattan—these mains to be tapped at predetermined points, preferably at the intersection of streets. At each of these intersections a manhole would be built, which would be capable of containing an electric motor and a suction and force pump. In each manhole a shut-off valve H would be placed, and the force pump would feed either into the continuing series of pipes or into a stand-pipe connected with an ordinary hydrant, as occasion required. These motors driving the pumps could be all connected with a central station at fire headquarters, or particular localities could be served from individual stations.

Referring to the diagram herewith, and assuming a fire in the block M the valves H in the manholes 1, 2, 3 and 4 would be closed, and the motors in these manholes set in operation from the switchboard at the central station. The pumps, then, would draw water from the source of supply and force it through the pipes of the system to the locality where the valves were closed. The pump nearest the supply would first draw water and deliver it to the next pump, which would, in turn, deliver it to the succeeding pump, and so on to where the water was needed. With such an arrangement as this around any block, there are a number of operative hydrants communicating with a practically inexhaustible supply of water.

This system may also be applied to modern high buildings. The mains can be connected directly to the service mains of the building, and upon several floors throughout the building motors and force pumps can be located. In this way an immediate supply of water would be available for checking any incipient blaze.

Reviews of Current Engineering and Scientific Literature.

A New Negative Plate for Storage Batteries.

A new method of making negative plates for storage batteries, which has been patented by MM. Routin and Mouraille, is here described. The sheets are woven of wire, consisting of an alloy of lead, antimony and sodium, and from this blanks are stamped out, which are then folded over a mandrel to form pockets. Around three sides of the pocket a band of the same alloy is cast. The pocket is then packed with active material containing a proportion of some inactive substance which is intended to make the material more porous and facilitate division. The opening of the pocket is closed when the terminal is cast on. These plates are said to retain their original capacity for a long time, and are not subject to buckling. The active material is fine and adheres closely to the support.—*Translated and abstracted from L'Électricien (Paris), January* 30.

Radio-Tellurium.

An intensely active material has been isolated from Joachimsthal pitchblende by Professor Marckwald, and has been called by him radio-tellurium. Mr. F. Soddy describes, in this communication, some striking experiments made by the discoverer with this material. The ionization of the air in the immediate vicinity of the active substance is so intense that a current sufficiently strong to ring an electric bell was enabled to pass through it, the air forming part of the circuit. Interposing a sheet of paper to screen the air from the preparation stopped the ringing of the bell. Leyden jars and other charged bodies were quickly discharged by the material, although there were but a few one-hundredths of a milligramme of the substance used. Professor Marckwald obtained less than four milligrammes of his substance from two tons of pitchblende. It is separated from the pitchblende by first separating ordinary tellurium, which is then precipitated with hydrazene hydrate, the new body remaining in the solution. The radiations from this body consist only of the non-penetrating variety, which is characteristic also of polonium, and Mme. Curie has protested against the name radio-tellurium being given to this body. However, the activity of polonium decays gradually, whereas Professor Marckwald states that the activity of the other is permanent. The author takes the view that Mme. Curie is right, and that there is not sufficient reason for giving a new name to this material. —*Abstracted from Nature (London), February* 11.

Overhead Electric Cranes in Central Stations.

In this communication the writer criticises the practice of equipping central stations with electric cranes, as he does not think that the saving in labor effected by their use will pay the interest on the cost of the crane. He estimates that the service of an electric crane costing from $3,000 to $4,000 would not average one hour per day, and during this time it would not save the work of more than one man, so that the labor dispensed with per year at the rate of twelve cents an hour would amount to only forty-five dollars. A crane operated by hand could be installed for from $2,000 to $2,500 less than the electric crane, and would do the work of the latter with the service of an extra man, or even without this additional assistance if one man were assigned to the control of the crane only. It is frequently said that the electric crane saves its cost by reducing the labor of the first installation, but it is rarely the case that power can be obtained to operate the crane. Where this can be done it may be advisable to install a crane, or when extensions are contemplated, but otherwise the author believes that a hand-operated crane will do the work at less cost.—*Abstracted from the Electrical Review (London), February* 12.

Electrostatic and Electromagnetic Separation of Minerals.

A comprehensive review of electrostatic and electromagnetic methods of separating metals has been prepared by M. D. Korda. The electrostatic method is first discussed with reference to the Blake machine. In this the pulverized ore is charged electrostatically and then allowed to fall through an electrostatic field, coming in contact with a plate charged in the opposite sense. At the moment of contact, the mineral particles which have a high conductivity become immediately charged in the opposite sense, and are repelled. Those having a lower conductivity are not discharged as quickly, and fall more nearly into a vertical line. Some of the results obtained with this apparatus are given. The electromagnetic separators are only applicable to magnetizable ores. There are many types. The operations of the various types are described and are classified according to whether the mineral is raised and transported by magnetic attraction, or according as its trajector, as it falls freely, is made to deviate by means of magnets. Some of the types shown are very ingenious, and figures are given of the performance with different types of ore.—*Translated and abstracted from the Bulletin de la Société Internationale des Électriciens (Paris), January.*

The Efficiency and Color of Osmium Lamps.

Some recent tests of the efficiency of osmium lamps have been made by Professor F. G. Baily. All of the lamps tested were rated at thirty-two candle-power and for fifty-five volts. They had much the same shape and size as a thirty-two-candle-power carbon lamp. There are three loops of wire, each anchored at the end, the total length being forty centimetres, with a diameter of 0.1 millimetre. The wire is very hard and brittle. The variation between the five lamps in efficiency and candle-power was slight, and a table of the mean values is given. This shows that at 45.5 volts the candle-power is 14.5 and the watts per candle 3.04. At 55.6 volts the candle-power is 32.6 and the watts per candle 1.89. At 60.6 volts the candle-power is 45.4 and the watts per candle 1.57. The candle-power does not vary as rapidly with the voltage as it does in the carbon lamps. No life tests were made, but Dr. Wedding found in testing eighteen lamps an average life of over 1,900 hours, and the average candle-power at the end of the life was about eighty per cent of the initial. The efficiency averaged 2.1 watts per candle. From these figures the author thinks that it is fair to consider the osmium lamp as having an efficiency at least twice that of the carbon lamp. The spectra of the osmium and the carbon lamps were compared, but no appreciable difference could be detected by the eye. Upon adjusting a carbon lamp until the light given by it was of the same color as that of the osmium, the efficiency of the carbon lamp was found to be somewhat less than that of the latter. This leads the author to the conclusion that the higher efficiency of the

osmium lamp is due principally to the higher temperature at which it operates, but the metal would seem to be a slightly better light radiator than the carbon. The color of the lamp is similar to that of a carbon lamp running at 2.1 watts per candle, and it is suggested that it would form an excellent secondary standard of light.—*Abstracted from the Electrician (London), February* 12.

Researches on the Three-Phase Arc.

A careful research into the possibilities of the three-phase arc has been made by M. P. L. Mercanton, and this article gives some interesting results which were obtained. The lamp used consists of three carbons arranged to form a cone clamped about a circular plate, with means provided for bringing the terminals together. One hand-screw tilted all three simultaneously, while independent adjustment of each carbon was possible. The three-phase arc plays between the three carbons, so that there are always two arcs burning, and six independent arcs are formed during each cycle. When viewed from the front end, three intensely brilliant points are seen, surrounded by a triangle of luminous gas. Photometric measurements show a fairly uniform distribution around the axis of the lamp. Thus, a lamp burning on thirty-eight volts and taking twenty amperes per phase at a frequency of 38.5 cycles per second, gave a luminous output varying from 5,670 Hefner candles to 7,810. This specific consumption in a cone having an opening of more than ninety degrees is less than that of the single-phase arc, the figure for the latter being 0.8 watt per candle and 0.6 watt per candle for the three-phase lamp. The light is quite steady at that frequency. In spite of these advantages the author does not think that the three-phase arc is commercial, because of the difficulty of constructing a lamp which would be automatic, it being necessary to regulate each carbon independently; and auxiliary apparatus would also be more expensive. For special cases, such as searchlights, where hand regulation is not a disadvantage, the three-phase lamp should be decidedly superior to the single-phase.—*Translated and abstracted from L' Éclairage Electrique (Paris), January* 30.

The Riedler-Stumpf Steam Turbine.

The Riedler-Stumpf steam turbine is a type intermediate between the de Laval and the Parsons. In actual construction, it differs considerably from other types. The buckets have a rectangular cross-section and are cut into the periphery of the wheel, so that they present an appearance somewhat similar to that of the well-known Pelton water-wheel. The buckets may be merely U-shaped with the steam impinging on one side, or double, in which case the jet of steam strikes a centre knife edge. The steam nozzle is drawn down to a rectangular cross-section from a round tube. It has been found from experiments that this form of jet has distinct advantages over the round. To reduce the speed, large wheels having a diameter of considerably over a metre are used. These wheels are made of ten per cent nickel steel, which, in addition to being exceedingly strong, has the advantage of not rusting. The peripheral speed is also reduced by the two-stage process. In this the steam leaving the jet strikes the buckets, and since the peripheral speed is maintained less than half that of the steam itself, the latter issues from the buckets with a considerable absolute velocity. It is then caught by spiral-shaped guides, turned through an angle of 180 degrees, and directed against the buckets of a second wheel, or a second point on the periphery of the first wheel. In this process it is necessary that choking of the guides should be prevented, which is accomplished by means of a compound guide that preserves a uniform distribution of the steam. The first experimental turbine of this type was tested at the Charlottenburg College. It was constructed with two rotors, each one and one-half metres in diameter and provided with simply U-buckets. When operated non-condensing but one wheel was used, two being employed when running condensing. This turbine showed a steam consumption of thirteen kilogrammes (twenty-six pounds) per effective horse-power. The second turbine of this type was installed at the Moabit generating station, a suburb of Berlin, and was rated at 2,000 horse-power. The diameter of the wheel was two metres, and the double U-shaped buckets were used. In constructing this turbine it was not attempted to obtain the highest efficiency, but the steam consumption was found to be eight kilogrammes per kilowatt-hour. The turbine runs at 3,000 revolutions, and takes steam at 188 pounds pressure, 560 degrees Fahrenheit. The rotor weighs 1,875 pounds. To obtain satisfactory balance at these high speeds the centre of gravity of the rotor is brought to within 0.01 millimetre of the centre of rotation, and fairly large shafts are employed.—*Abstracted from Engineering (London), February* 12.

Additions to the Shawinigan Falls Power Plant.

It appears that the amount of power available at Shawinigan Falls is greater than at first supposed, and the hydroelectric plant there will probably utilize the entire flow of water before long. The company recently installed a new generating unit with a capacity of 6,000 horse-power. The turbine is of the horizontal shaft type, constructed by Escher, Wyss & Company, of Zurich, Switzerland, and operates with a net fall of from 125 to 235 feet, revolving at a speed of 180 revolutions per minute. This turbine drives directly a two-phase generator rated at 3,750 kilowatts. The generator was manufactured by Dick, Kerr & Company, of London. It is of the revolving field type, and generates at 2,000 volts, thirty cycles per second.

The Shawinigan company has agreed to furnish power to Sorel, Quebec, and has completed the transmission line. A transformer station has been located at Jolliette, where the 50,000 volts of the line will be lowered to 12,500. A line runs from here along the banks of the St. Lawrence, and near Lanorale crosses the river by means of a submarine cable heavily insulated and armored. The company is now delivering 5,000 horse-power to Montreal, and, in accordance with the agreement made with the Montreal Light, Heat and Power Company, is erecting a second transmission line, which will be a duplicate of the first and will have a capacity of 10,000 horse-power. It is expected that other short lines, similar to the Sorel line, will be erected, and power distributed to points within a radius of eighty-five miles.

Electrons in Metallic Conduction.

In a paper published in the *Philosophical Magazine* for February, Mr. A. Schuster proves that the number of free electrons in a metal is at least equal to the number of metallic atoms in the same volume, and that it does not exceed the number of atoms more than three times. This law has been deduced from optical considerations. In mercury, nickel and bismuth he finds that the number of free electrons is practically the same as the number of atoms. The ratio of the number of electrons to the number of atoms is less than three for all metals excepting aluminum. For copper, silver and gold the ratio is less than 1.6. For other metals the ratio is greater than this, and for no metal is it sensibly less than unity. To explain metallic conduction, it is suggested that each atom is possessed of from one to three negative electrons, which are detached and follow freely the electric force, even for oscillations as rapid as those of light.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Triumph Electrical Apparatus.

The apparatus of the Triumph Electric Company, of Cincinnati, Ohio, has been well known to the electrical field for a long time. The accompanying illustrations show some of the types of machines which this company is now manufacturing, and give a few details of the construction.

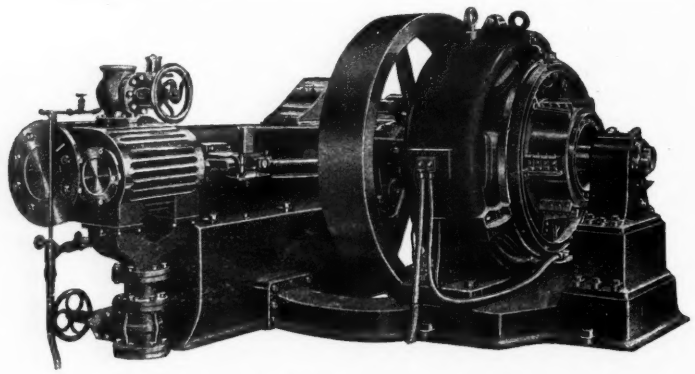


FIG. 1.—100-KILOWATT ENGINE-TYPE GENERATOR.

Fig. 1 shows a 100-kilowatt engine-type generator, direct-connected to an automatic high-speed engine. This type of generator is made in sizes from twenty-five kilowatts and upward. Fig. 2 shows a 150-kilowatt two-bearing belted generator, which type of machine is made in sizes from five kilowatts to 150 kilowatts. Fig. 3 shows a line of steel-frame bipolar motors and generators, and Fig. 4 shows the frame, armature, poles and field coils of a one-half-horse-power steel frame motor.

The frames of all machines are of a multipolar design, four, six and eight poles, according to the size, except three small sizes, which are bipolar. The frame proper is of soft close-grained cast iron, with pole-pieces of a laminated type, except in the smaller sizes. The laminated poles are built up of discs of thin sheet iron, and are cast-welded into the frame. These discs, before they are put together to form the pole, are annealed and specially treated, whereby eddy currents are reduced to a minimum. The poles are fitted with a special design of pole shoe, so that the proper magnetic fringe is provided.

The bearings are of the best gun metal, of the ring-oiling self-aligning type. Oil wells of ample capacity are provided in each pedestal, and are fitted with a glass gauge and drain cock. Bearings are made to standard gauge and reamed, so that they are interchangeable and easily replaced.

Fig. 5 shows the bar-wound armature which is common to both belted and engine-type generators. These are of the iron-clad laminated-core toothed type, of bar-wound construction. In the smaller sizes and also for the higher voltages these are wire-wound. The armature conductors or windings, whether of bar copper or of wire, are formed into shape and thoroughly insulated and tested before being placed in position on the armature. The insulation consists of their first being dipped in a special insulating and waterproof varnish, and then wrapped with heavy linen tape, after which they are again thoroughly saturated with special insulating and waterproof varnish. In addition to the insulation on the coils or windings, the slots in the core, into which they are placed, are insulated by troughs of alternate layers of fuller board, mica and oiled paper.

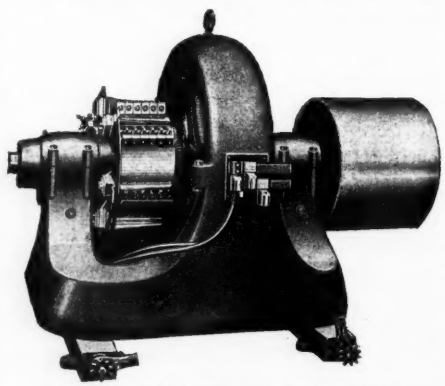


FIG. 2.—150-KILOWATT, TWO-BEARING, BELTED GENERATOR.

The armature core consists of discs of thin sheet iron, which are annealed and specially treated before being placed together. In the smaller sizes the discs are mounted and keyed directly on the shaft, while in the larger sizes they are mounted upon a spider which is keyed to the shaft. Thorough ventilation is provided by openings running parallel with the shaft, with frequent apertures extending to the circumference.

The segments or bars of all commutators are of hard-drawn or of drop-forged copper. They are mounted upon a cast-steel shell, and are insulated from it and from each other with the best mica, of such quality that it will wear evenly with the bar.

The field coils are form-wound, and are thoroughly insulated and tested before being placed in the machine. Fig. 6 shows a shunt and series field coil. The coils are first wound into form, during which process each layer of wire, as it is wound on the form, is insulated from the preceding coil by a layer of fuller board. After the coil is wound into form it is first dipped into a bath of insulating varnish, then thoroughly baked, after which it is covered with heavy fuller board, mica and canvas, with a layer of tape over all. It is then corded and finished with a coat of insulating and waterproof varnish.

Shunt coils are wound both ways from the centre, so that both leads are on the outside. With all compound-wound machines, excepting the small sizes, the shunt and series coils are separately wound, and

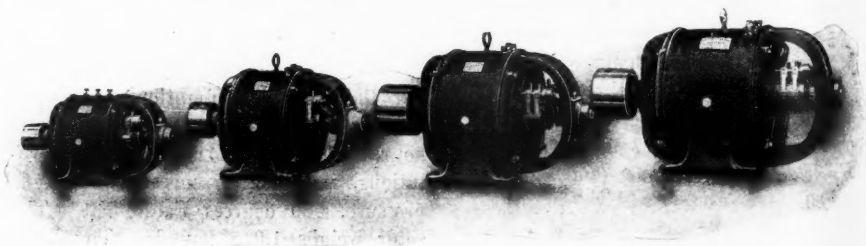


FIG. 3.—STEEL FRAME BIPOLAR MOTORS AND GENERATORS.

in such cases the series coil is of solid bar copper, one turn to the layer, designed to wind to the same height as a shunt coil. The coils are mounted on the poles, with spacers between the series and shunt, as may be seen from the illustration. This allows of a free circulation of air. The coils are then held in place by the pole shoes.

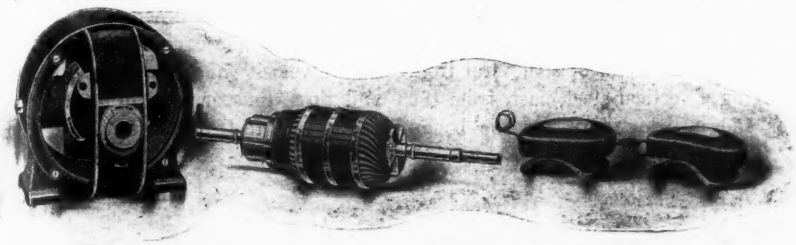


FIG. 4.—FRAME, ARMATURE, POLES AND COILS OF ONE-HALF HORSE-POWER STEEL FRAME MOTOR.

The coils are connected together with heavy leaf-copper leads and copper-clamped connections. These connections are made under the field rings, eliminating the danger of their being broken or injured mechanically.

Fig. 7 and Fig. 8 show, respectively, convolute and the hinged radial brush-holders. All brush-holders are designed for the use of carbon brushes, and the brushes are of such size as to carry not more than thirty amperes to the square inch. Two types of brush-holders are used, according to the size of the machine and the voltage. With the smaller machines and the larger sizes of high-potential, a sliding-contact convolute type is used, while with the low-potential large machines, a positive-clamp hinged radial type is used.

The steel-frame bipolar machines are designed to meet the requirements for an extremely compact and strong machine of light weight, which will be capable of withstanding fluctuating loads and heavy overloads. The machines are of bipolar steel-frame type, made from one-half to five horse-power, inclusive, in motors, and one-half to five kilowatts, inclusive, in generators. The crown and pole-pieces are made of soft close-grained steel. The poles are accurately fitted and bolted to the crown. Cast-iron yokes, heavily ribbed, are centered against the sides of the crown, and are held firmly in position with bolts. The bearings are of metal, of the self-oiling type, and are interchangeable.

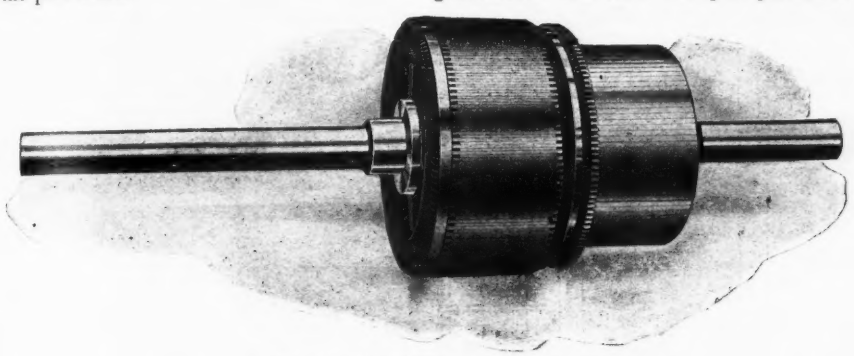


FIG. 5.—BAR-WOUND ARMATURE.

FIG. 6.—SHUNT AND SERIES FIELD COILS.

FIG. 7.—CONVOLUTE BRUSH-HOLDER.

In addition to the engine and belted-type generators and motors for all classes of service, the Triumph Electric Company manufactures several types of special machines, such as double generators, boosters, equalizers and motor-generators.

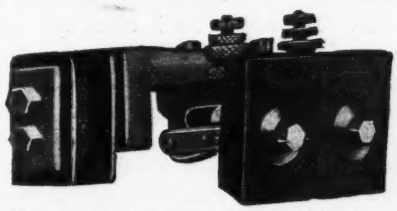


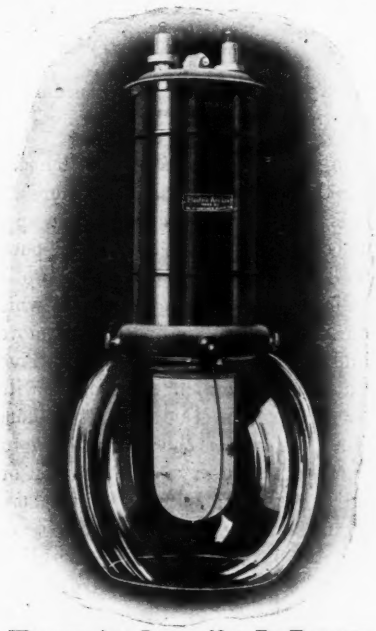
FIG. 8.—HINGED RADIAL BRUSH-HOLDER.

The Warner Arc Lamp.

The accompanying illustration shows the new form of Warner arc lamp. This lamp has been designed and is made by Mr. W. F. Warner, of Muncie, Ind. Mr. Warner has been engaged in the electric lighting business for the past twelve years, and has designed this form of enclosed arc lamp, which can be used in connection with the old high-tension 9.6-ampere machines. The lamp shown in the illustration is a radical departure, and is meeting with much favor among electric light people, as it not only saves considerable time in trimming, but obviates the liability of broken globes. Quite a number of central stations still use the old 9.6-ampere machines, and this lamp has found a popular field among this class of stations. The lamp shown may be trimmed without taking the outer globe off.

The city of Muncie, Ind., is entirely lighted by this lamp, there being in use 230 lamps operated with three Western Electric and two "Wood" old-style 9.6-ampere dynamos.

The lamp is made with proper arrangements and attachments for indoor use, and a considerable flexibility in installation is given by its facility to operate two in series on a 220-volt direct-current circuit, or five in series on a 500-volt direct-current circuit.



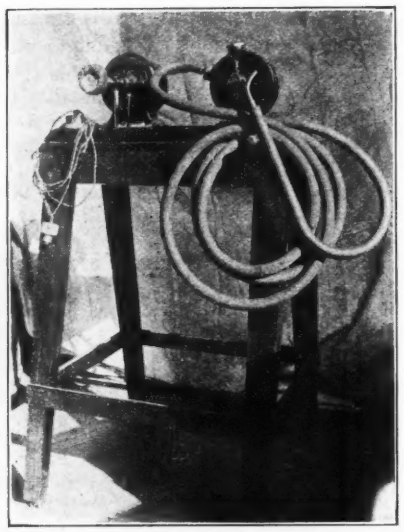
WARNER ARC LAMP—MAY BE TRIMMED WITHOUT REMOVING OUTER GLOBE.

A New Mercury Vapor Lamp.

It is reported in *L'Industrie Electrique* (Paris) for January 25, that C. O. Bastian has brought out an improved form of mercury vapor lamp which gives a white light that enables colors to be sorted satisfactorily. The method of doing this is not given, but it is said to be at some sacrifice in efficiency.

Apparatus for Cleaning Telephone Switchboards.

The accompanying illustration shows a very useful and economical apparatus for cleaning telephone exchange switchboards. All those who are familiar with the telephone switchboards and their accessories, know the difficulty of keeping them free from dust, corrosion, and the trouble resulting therefrom. More especially is this

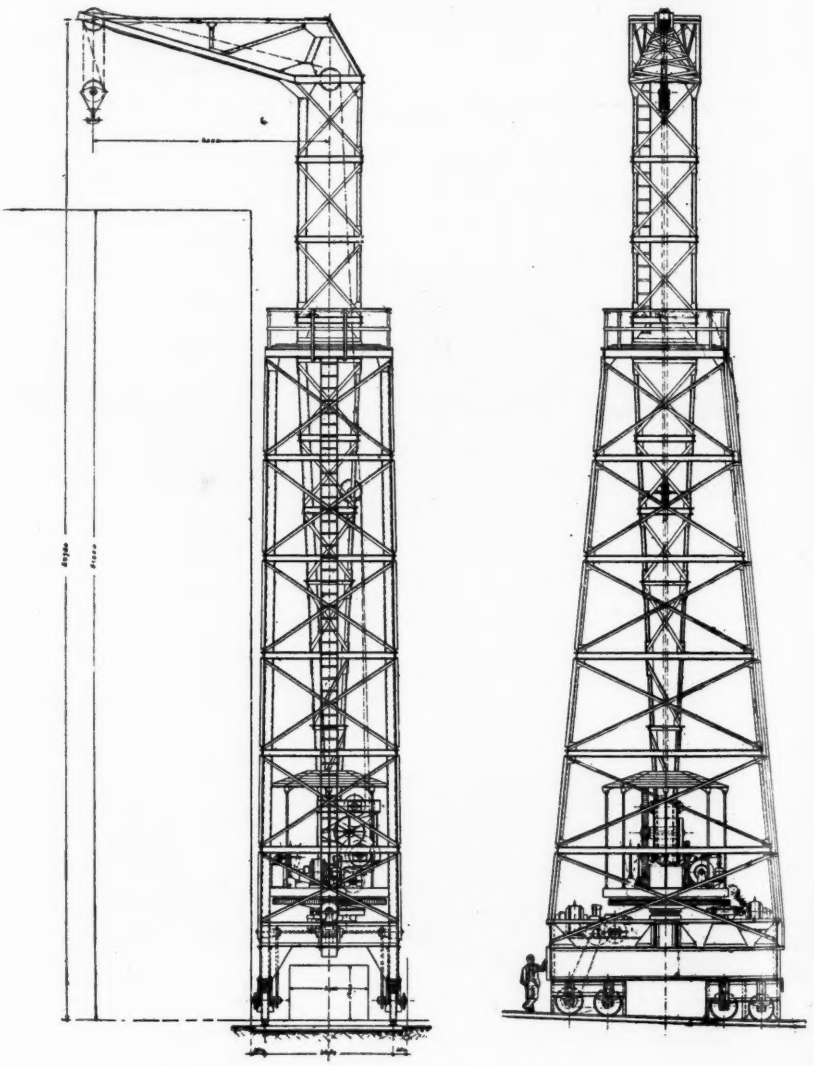


APPARATUS FOR CLEANING TELEPHONE SWITCHBOARDS.

true of the common battery switchboard where cabling and wiring are more numerous and difficult of access. The apparatus consists of a one-eighth-horse-power motor belted to an air blower, the two being mounted upon a wooden horse which is on rollers and can easily be moved around the room by the operator. There are a plug, extension cord and switch for making connection with the house lighting system for operating the motor. The motor has an extension shaft on one side that carries a buffer. This is used for polishing plugs, to ensure perfect contact in the spring-jacks. The air blower has attached about twenty feet of rubber hose with nozzle. With this apparatus switchboards can receive a systematic, rapid and economical cleaning. The device was got up by J. E. Peavey, of the Cincinnati & Suburban Bell Telephone Company, of Cincinnati, Ohio, where it has been giving excellent service for some time.

An Electric Tower Crane.

Although the electric crane has become an important part of the equipment of every important power station, the advantages of this type of transporting device have seldom been made use of elsewhere. For this reason a description of a new type of crane recently employed in constructing a large building in Brussels may be interesting. The building in question was seventy-five feet high and 650 feet long. This crane, as will be seen from the accompanying illustration, consists of a tall tower of structural iron, supporting a vertical steel mast, from the upper end of which projects the boom.



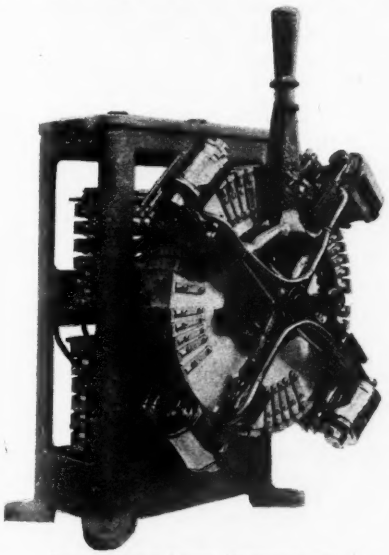
ELECTRICALLY DRIVEN TOWER CRANE.

The tower is mounted on wheels and travels on a railway laid down in the street. The rail gauge is about ten and one-half feet, the width of the street being twenty-two feet. The crane is moved along this track by means of a motor placed on a platform overhead and geared to the running wheels by chains. This was necessary in order that a clear runway might be maintained under the crane, for delivery and storage of material.

The crane is operated by three motors, one moving it along the track, one revolving the mast, and the third lifting the load. The height to which loads can be lifted is eighty-two and one-half feet, and the distance from the hook to the centre of the mast is nineteen and one-half feet. The crane can lift ten metric tons with a velocity of sixteen feet per minute, and three tons or less with a velocity of fifty-seven feet per minute. It moves along the track with a speed of 130 feet per minute. The crane is controlled by one man placed on the lower platform, but there is an upper platform where another man can be placed for signaling. It can be erected for use in a very short time, and where desirable, can be shortened. By means of its use the building mentioned above was constructed promptly, and probably at a less cost than could have been done by ordinary means. The crane was constructed by the Gesellschaft Elektrotechnische Industrie, Karlsruhe (Baden), Germany.

Regulating and Reversing Controllers.

Controllers for motors used upon cranes and in other places where frequent stops and reversals are necessary must have unusual sturdiness, in order to withstand the strain and wear of constant motion. They must also be simple and positive in action in order to give perfect control of the



COMMUTATOR TYPE CONTROLLER.

motor, both in speed and direction of rotation, and with the fewest possible movements of the handle, for with the almost incessant operation of the controller any inconvenience in manipulation would be a serious drawback.

To meet the peculiar requirements of such service, controllers possessing the desired features have been designed. One style of such a device, the commutator type, as made by the Westinghouse Electric and Manufacturing Company for use with direct-current series, shunt and compound motors, is shown in the accompanying illustrations. In form and construction it is unlike any other controller and its design enables the manufacturer to give special prominence to the qualities most desirable in an appliance of this kind.

For convenience in installation, it is made in two forms. In type No. 178 the controlling mechanism is mounted on the side of the frame containing the resistance, and in type 179 it is mounted above the resistance as shown. The space available for installing controllers for motors used with cranes and other machinery is usually greatly restricted, and this provision for adapting the device to the place in which it is to be used is of corresponding value.

The controlling mechanism is mounted upon a circular slab or base of insulating material, which provides high insulation between adjacent contacts and between the contacts and ground. Throughout the entire controller ample provision for insulation is made.

Both the contact and finger tips can be easily removed and renewed without disturbing the connections. The contacts are arranged in parallel rows along the periphery of the disc, the relative position of the contacts and the finger tips being the same as that of the brushes and commutator in a generator or motor—a form which has been found more desirable than any other for this particular service. The same contacts are used for application of the current in either direction, thus lessening the number required, while an effective magnetic blow-out makes it impossible to maintain an arc and prevents burning of the contacts.

Each controller has four brush-holders

COMMUTATOR TYPE CONTROLLER.

mounted upon a rocker arm to which the handle is attached directly, working without gears or pinions. A single movement to right or left applies or reverses the current, and the distance the handle is moved determines the motor speed by varying the amount of resistance in series with the motor armature. There are sixteen steps in each direction, and a very close regulation of the speed is thus obtained.

When the controller is placed in the rear of a crane cage, it is operated by a crank and lever directly attached to the spider which carries the brushes. Type No. 179, with the controller mounted above the resistance, is very generally employed for this purpose.

The resistance used with controllers of large capacity is of the grid type, a form the desirability and simplicity of which are universally conceded. For small capacities with large ohmic resistance an improved coil resistance is employed with ventilating spaces between the cells, which are separated by non-combustible insulating spreading blocks. This form provides excellent ventilation, insulation and durability. The resistance is varied for the different capacities and uses of the motor which the controller governs, a different resistance being used for crane controllers where a close regulation is required than is provided for roll tables and soaking pits where sudden and repeated starting and reversing is the prime requisite.

The chief characteristics of this type of controller are its simplicity, strength, durability, flexibility of application and ease of manipulation. Any mechanic can care for it, and keep it in order; the cleaning, oiling and renewal of contacts when necessary being all that is required. All parts are exposed to view, and connections are easily made.

Controllers of the commutator type are made regularly in capacities from ten to seventy-five horse-power, and can be furnished especially of any capacity desired. For less than ten horse-power, the Westinghouse company makes a face-plate type of controller which contains many of the main features of the device described.

It is small and compact; has contacts and finger tips which are easily renewed without disturbing the connections; has a powerful magnetic blow-out, and in prin-

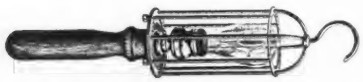
DIAL TYPE CONTROLLER.

ciple and manipulation is the same as the commutator type. The resistance used is especially designed for the purpose and is particularly effective and durable, withstanding an extraordinary amount of heat without impairing its efficiency. This controller is known as type No. 177.

The three types illustrated afford a choice of a regulating and reversing controller suitable for any service within the range of capacity named.

A Portable Lamp Guard.

The Crescent portable lamp guard, an illustration of which is here shown, is especially adapted for use in machine shops, engine and boiler rooms, bank vaults, basements, and, in fact, anywhere



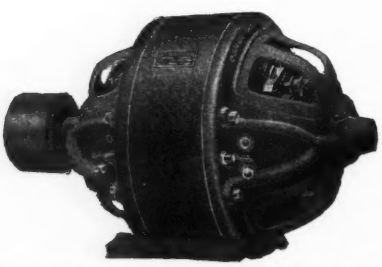
A Portable Lamp Guard.

where it is desirable to carry a lighted incandescent lamp short distances.

Its construction is such that, while it is strong enough to stand the hard usage of a boiler room, it is sufficiently ornamental for offices. This device is manufactured by the Crescent Company, 405 Omaha Building, Chicago.

Variable Speed Motors for Single Voltage.

The Commercial Electric Company, Indianapolis, Ind., having made a careful study of conditions obtaining in special adaptations of motor driving for machine tools, has placed on the market a new line of apparatus. This line of motors has been designed for that service where a great variation in speed is required, with the heaviest torque at the slowest speed,



Constant Voltage Variable Speed Motor.

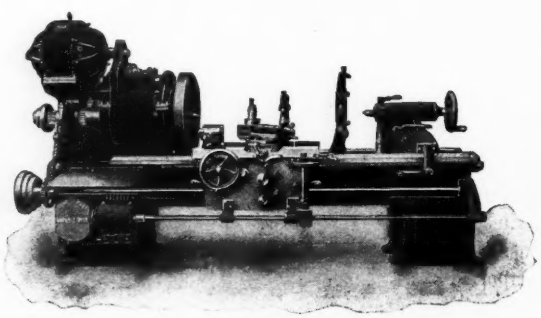
and a less torque at a higher speed, the actual horse-power or rate of doing work being the same at all speeds. Lathes, boring mills, milling machines, drills, with many others, belong to this class, and to secure the greatest output from them it is necessary to run the work at the greatest cutting speed and take the heaviest cuts the tool will stand, whatever may be the nature of the work.

To effect the variation in speed a double-commutator motor is employed having two different windings, but each winding is of the same size conductor, or of the same ampere capacity. A speed controller is furnished for making the necessary combination of these armature windings and for varying the field strength to secure intermediate steps between the armature combinations. These controllers are simple and compact and the changes from

Interlocking Speed Controller.

minimum to maximum speed are easily and quickly effected. The controllers are made reversible.

Included in the controller is the rotary starting and reversing switch, by means of which the motor is started, stopped and reversed, while the speed control is set at any desired point. The speed controller and starting switch are combined into one piece of apparatus and enclosed in a compact case which can be placed at any desired point on a driven tool, or which can be mounted on a stand conveniently located at the side of the tool. The controller



Variable Speed Motor Driving Lathe.

may or may not contain a main switch, as desired.

The manufacturer claims the following distinctive feature: a range in speed of four to one in twelve uniformly graded steps, without overlapping; the greatest torque at lowest speed; a constant maximum horse-power at all speeds; a practically constant speed at all loads; and it can be installed on any standard two-wire or three-wire system.

In tests the machine gave high efficiencies on slow and medium speeds. The motors are built in sizes ranging from two to twenty horse-power, the speeds ranging, respectively, from 250 to 550 minimum, and from 1,000 to 2,200 revolutions per minute maximum.

Creosoted Timber.

The United States Government has been making a study of wood preservation and after thoroughly investigating the different methods it states that the dead oil of coal tar process is the best and has proven to last the longest.

It is interesting to note in this connection that the dead oil of coal tar process has been for a long time extensively applied by the Wyckoff Pipe and Creosoting Company, Incorporated, whose offices are at Stamford, Ct., and works at Portsmouth, Va. This company has been creosoting timber since 1881 and, as many of its installations have been in successful use for twenty years, it has had every opportunity to study and apply the best methods for each kind of timber as used for railroad ties, wharf and bridge timbers, conduits for underground wires and cables, poles, cross-arms, piles, paving blocks, fence posts, etc. Railroad ties treated by this process will wear out, but will never rot out. Among the company's important customers are the Bell telephone companies, which purchase millions of feet of conduit every year.

The method applied by this company in preserving wood is to first subject the timber to live steam to draw out the sap, after which creosote oil (dead oil of coal tar) is forced into the wood under high pressure. This method has proven so satisfactory that the company is willing to guarantee that its creosoted timber will never rot. It should be noted that, as creosoted timber is an excellent insulator, it is doubly valuable on third-rail systems and other electrical installations. Only recently several carloads of creosoted lumber were shipped by this company for insulating third rails in mines.

Some time ago the company received a number of pieces of conduit from the Bell Telephone Company, of Philadelphia, with the statement that it was obliged to take up some of the Wyckoff conduit, laid fifteen years ago, on account of the subway now being built by the Philadelphia Rapid Transit Company. The Bell company wrote that every piece was found to be in a perfect state of preservation, and that even the small tenons were as sound as the day they were laid. The United States Agricultural Department has asked for a piece of this conduit, to be put on exhibition in Washington, and also has made a request for two pieces to be sent to St. Louis.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

BERLIN-HAMBURG TROLLEY PLANNED—At a meeting on February 23, at Berlin, Germany, of the budget committee of the Prussian Diet, General Buddle, minister of public works, informed the members of the committee that the minister of railroads was considering an application for a charter to construct a rapid transit electric railroad between Berlin and Hamburg, the company to have a capital of $37,500,000.

GENERAL ELECTRIC COMPANY'S LONDON CONTRACT—The British Thomson-Houston Company, Limited, of Rugby, England, has secured the contract from the Underground Railway Company, of London, for the motor equipment to be used on the underground and surface electric traction system of London. The company will furnish 480 cars equipped with motors aggregating 500 horse-power per car. With other equipment, the contract is expected to be worth some $7,000,000.

ERIE PASSENGERS TO HAVE A TUNNEL CONNECTION—Arrangements have been made between the Erie Railroad and the New York & New Jersey Railroad, by which the Erie will secure the right to send its passengers through the tunnel under the Hudson river, which the New York & New Jersey Railroad Company has nearly completed. This arrangement will be simply in the form of a traffic agreement. The tunnel begins on the Jersey side, at a point adjoining the terminal of the Erie, and very near to the terminal of the Delaware, Lackawanna & Western. At the Manhattan side it ends at a point where passengers can be transferred to the Metropolitan railway surface lines or the Ninth Avenue Elevated Railroad. The tracks of the tunnel company will be extended into the Erie terminal, so that passengers of the railroad, without leaving the Erie station, can enter cars bound through the tunnel. The passengers will, of course, have the option of using the ferryboats if this is preferred.

THE PANAMA CANAL COMMISSION—The following announcements have been made of the appointments to the Panama canal commission, which will have charge of the work of building the Panama canal, the Panama treaty having been signed by President Roosevelt on February 25: Rear-Admiral John G. Walker, U. S. N., retired, chairman; Major-General George W. Davis, U. S. A., retired; Colonel Hecker, of Michigan; William Barclay Parsons, of New York; Professor William H. Burr, of New York; C. Ewald Grunsky, of California, and B. M. Harrod, of Louisville, Ky. It is understood that the entire canal subject will be placed under the control and direction of the War Department, and legislation to put this plan into effect will be asked for. It has been decided that the canal zone will be policed by troops of the regular army, and it is also known that a great many of the engineers of the army will be used in connection with the work of construction. For this reason the War Department should have control.

SUBWAY COMPETITION IN NEW YORK CITY—The Metropolitan Street Railway Company has submitted a plan to the rapid transit commission of New York city, upon which it will bid for tunnel facilities. The plan provides for subways on both sides of New York city, to tap such arteries of traffic as the Grand Central Station, the Brooklyn Bridge, the ferry terminals at the Battery, the tunnels under the North river, now being built between New Jersey and Manhattan, and the new Pennsylvania Railroad station at Thirty-second street. The route the Metropolitan company suggests is a most practicable one for both long and short-haul trips. The company has in service now some 300 miles of surface lines on Manhattan Island, and one of the most attractive features of its bid for franchise facilities is the giving of free transfers to all points which the subway will tap, and meeting its intersecting surface lines. The plan which the Interborough Rapid Transit Company—the company which is to operate the present subway system—has forwarded calls for a route which is practically parallel to the Metropolitan company's route at each point.

WIRELESS TELEGRAPHY IN THE UNITED STATES ARMY—It is announced that, after an experimental period of six months, considerable success has been attained between the wireless telegraph stations at Fort Wright, Fisher's Island, and Fort Schuyler, N. Y., a distance of ninety-seven miles. Messages of 1,000 words each have been exchanged, and read as distinctly as an operator could read on a land line, at a speed of thirty words a minute. The line at Fisher's Island was operated by Captain Leonard D. Wildman, of the United States Signal Corps, who since 1899 has been in charge of the government wireless experiments. The system established between these points is intended for use between St. Michael's and Nome, Alaska, where it has been impossible to establish ground lines, because, during the winter, the cables are wrenched away by the ice. It is stated that upward of $350,000 has been expended to establish a land telegraph line, but without success. The instruments for the new system are simple, an ordinary Morse key being used in the sending. The government apparatus adopts the ideas of various wireless methods, parts having been taken from a number of systems, with the idea of securing instruments least liable to breakage.

AUTOMOBILE NOTES.

BRITISH INTERNATIONAL CUP RACE FOR MOTOR BOATS—The Automobile Club of America, New York city, N. Y., announces that the Automobile Club of Great Britain and Ireland has extended the time of receiving entries for "The British International Cup Race for Motor Boats" (formerly "The Harmsworth International Cup Race for Motor Boats") to June 30, 1904. The Automobile Club of America will accept entries for this race until June 1, 1904. A deposit of $100 must accompany each entry, which sum will be returned in case the boat starts in the eliminating trials. All entries must conform to the "Conditions under the Deed of Gift and the Rules Pursuant to the Deed of Gift," a copy of which may be had upon application to the Automobile Club of America. The date of the race has been fixed to take place in the Solent on July 30, 1904.

SERVICE TEST OF MOTOR WAGONS—The Automobile Club of America will hold during the week beginning April 4, 1904, a service test of motor wagons. This will be open to motor wagons used for commercial purposes, made either in the United States or abroad. The classification will be on the basis of dead load carried, all wagons of like weight, whether steam, gasoline or electric, to operate in the same class. The following six classes have been established, to carry a respective dead load of 1,000 pounds or under, 1,000 to 2,000 pounds, 2,000 to 3,000 pounds, 3,000 to 4,000 pounds, 4,000 to 5,000 pounds, and 5,000 to 6,000 pounds. In order to give each vehicle a thorough and practical test, it will be placed under actual working conditions in the service of the American and Westcott Express companies for one week, from April 4 to 9 inclusive, and will transfer and deliver merchandise, produce, baggage, etc., from various depots of these companies during the entire week. Awards will be made in each class for the best performance, based on economy of operation in time and fuel, ratio of paying load, ton mileage, and general reliability and availability for service.

OBITUARY NOTICE.

GEORGE FREDERICK GILBERT died of typhoid fever at St. Mary's Hospital, Rochester, N. Y., on January 12, 1904, aged 42 years. Mr. Gilbert was a resident of Lakeville, Livingston County, N. Y. For several years he was engaged in the produce business and was postmaster for four years under Cleveland. In 1896 he became connected with the H. W. Johns-Manville Company, New York, and was its general sales agent for northern and western New York. He also represented the company in connection with work for the state government. In 1890 he married Miss Mary Halleran, at Rochester, N. Y., who, with his mother and a brother, survives him.

TELEPHONE AND TELEGRAPH.

CLAREMONT, N. H.—Albert F. Hildreth has bought the plant, franchise, etc., of the Hollis Telephone Company.

GREENVILLE, TEX.—The Southwestern Telephone Company will expend $15,000 in additional improvements to its system in Greenville.

CITY OF MEXICO, MEXICO—A long-distance telephone line will be placed in operation between Torreon, in the state of Coahuila, and Durango.

OXFORD, MISS.—J. M. Tatum and others have been granted permission by the board of supervisors to erect a telephone line from Burgess to Oxford *via* Taylor's and Splinter. Work will begin as soon as the right of way can be secured.

CHERRYFIELD, ME.—The New England Telephone and Telegraph Company is making additions to its system in Cherryfield and Milbridge. The company will soon connect with the Deblois & Beddington Telephone Company's line, giving its subscribers communication with a large number of towns.

SAN DIEGO, CAL.—A franchise for the operation of a telephone system in this city has been awarded by the city council to Arthur Wright, of Los Angeles, acting for the Home Telephone Company, a separate corporation of which is to be formed in this city. The sum of $250,000 is to be expended in installing the system, and contracts for material will be let at once.

CLARKSVILLE, TENN.—Arrangements are being completed to extend the lines of the Clarksville Home Telephone Company to Hopkinsville. Plans are also being made to give the patrons of the company a through circuit to Louisville from Clarksville. This will open up Bowling Green and all of the independent plants of Kentucky now connected to the Louisville Independent Long-Distance Telephone Company.

LEGAL NOTES.

MICHIGAN ELECTRIC COMPANY HAS RECEIVER APPOINTED—The Michigan Electric Company, Detroit, Mich., was placed in the hands of a receiver on February 19, 1904. The Union Trust Company, of Detroit, was appointed by the stockholders to protect their interests. The Michigan Electric Company has sent a circular letter to each of its creditors, stating that it had been found difficult to meet liabilities as fast as they matured. It was therefore deemed wise to take such steps as would prevent unnecessary interruption to the valuable business it had built up, and it desired to fully protect its creditors' interests. It had therefore executed and delivered a mortgage on all of its assets to the Union Trust Company, of Detroit, as trustee.

WAGNER ELECTRIC MANUFACTURING COMPANY SECURES TWO FAVORABLE DECISIONS—In the Circuit Court of the United States for the eastern district of Missouri, Judge Adams handed down a decision in the suit of the Thomson-Houston Electric Company, complainant, *versus* the Wagner Electric Manufacturing Company, defendant, in the litigation on the Thomson patent No. 363,186. In this case the motion for a preliminary injunction is denied. In another case in the same court and before the same justice, in a suit between the Westinghouse Electric and Manufacturing Company, complainant, and the Wagner Electric Manufacturing Company, defendant, an opinion was filed on the final hearing February 13, 1904. This is a suit based on the fourth claim of letters-patent of the United States No. 366,362.

TROLLEY LINES MUST PAY CAR TAX—An opinion filed on February 23, at Trenton, N. J., by Supreme Court Justice Dixon, gives Jersey City a victory in its litigation to recover more than $200,000 due in taxes from trolley companies having lines within the city. The decision involves three suits instituted by the city against the Jersey City & Bergen Street Railway Company and its successors, the Consolidated Traction Company, and the North Jersey Street Railway Company. In 1859 a franchise was granted to the Jersey City & Bergen Street Railway Company, which provided that the company should pay Jersey City a tax of $10 a car for each car operated. This tax was sanctioned by an ordinance passed by Jersey City, and which was ratified by legislative action in 1861. There was no failure on the part of the company to pay the tax until 1868. Since that year the tax has not been paid.

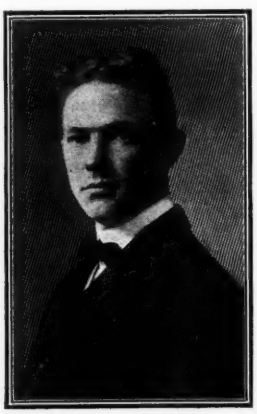
INDEPENDENT TELEPHONE FRANCHISE DENIED IN NEW YORK CITY—The Appellate Division of the Supreme Court has handed down a decision defeating the plans for laying an independent telephone system in New York city. This decision affirms an order by Justice Clark during the special term, denying a motion for a peremptory writ of mandamus asked for by the Independent Telephone Company, of New York, to compel Robert Grier Monroe, then commissioner of water supply, gas and electricity, to issue a certain permit. The company had asked permission to lay and maintain telephone wires in the low-tension subway and have additional subways of this nature constructed in various localities. Commissioner Monroe refused to grant the permit, on the ground that he had been advised that the company had no franchise or right to construct and maintain such structures and fixtures as were called for.

PRELIMINARY INJUNCTION DENIED—Judge Seaman, in the Circuit Court of the United States for the eastern district of Wisconsin, in the suit of the Westinghouse Electric and Manufacturing Company *versus* the National Electric Company, denied, on February 5, 1904, the motion for a preliminary injunction under the bill alleging an infringement of Tesla patents for electrical transmission of power and for specific motors. The patents in suit were Nos. 381,968 and 322,280 for the fundamental invention, and Nos. 389,961 and 382,281 for specific means. In the decision the court reviews prior cases and concludes as follows: "The question of infringement in the present case under the fundamental patents depends upon the scope of invention and involves a broader construction than was involved in either of the prior cases.

* * * *

I have carefully examined, to that end, much of the expert testimony, and while I am impressed with the force of the contention urged on behalf of the complainant, as to the true advance in the art made by the Tesla discovery and the scope of invention therein, the issues now raised require hearing upon complete proofs. So considered, discussion of the merits of the present controversy is unnecessary and inadvisable, and the motion for a preliminary injunction must be denied."

PERSONAL MENTION.



MR. I. A. BENNETT.

MR. I. A. BENNETT, general sales manager for the Electric Appliance Company, Chicago, has resigned his post, to take effect March 1, and will open the Chicago offices of the Phelps Company, of Detroit, Mich., manufacturer of the Hylo turn-down lamps and other specialties. Mr. Bennett resigned a position that he held with the Electric Appliance Company for a considerable length of time, having altogether served with this company for about eleven years, having previously been connected with the Ansonia Electric Company. Mr. Bennett's energy as a sales manager, and originality as an advertising man, has made him one of the best-known men in the electrical business, and he is receiving congratulations on all sides on his entrance into a field which promises handsome returns. Mr. Bennett has also accepted the presidency of the Central Station Publishing Company, which is being formed for the promotion of central station advertising. Mr. Bennett's new offices will be located in the Monadnock Building, rooms 529 and 530. He will carry a full and complete stock of every style, base and voltage, Hylo lamps, and specialties, making shipments from Chicago stock.

MR. R. W. MEYERS has been appointed chief electrician of the army post at Presidio, Cal.

MR. W. R. HANEY has been appointed superintendent of the electric light plant at Warren, Minn.

MR. F. A. NIMS has been elected president and Mr. T. S. Barber secretary of the Muskegon Light, Heat and Traction Company, Muskegon, Mich.

MR. GEORGE W. WILDIN, for the past three years mechanical engineer of the Central Railroad of New Jersey, has been appointed assistant mechanical superintendent of the Erie Railroad, with headquarters at Meadville, Pa.

PROFESSOR M. I. PUPIN, of Columbia University, who has been abroad attending the suit for patent rights in Germany, which has been pending for more than a year, returned recently from Naples on the Cunard liner Carpathia.

MR. WINSLOW H. HERSCHEL, C. E., who has been stationed at the Jerome Park Reservoir, aqueduct department, New York city, N. Y., has resigned his position to sail for Zurich, Switzerland, where he will remain for a year as local agent and technical correspondent for the Allis-Chalmers Company, Chicago, Ill.

MR. WILLIAM M. SCOTT, of the Cutter Electric and Manufacturing Company, Philadelphia, Pa., was announced to lecture before the section meeting of the Franklin Institute, Philadelphia, Pa., on March 3. At the same meeting Mr. J. Hart Robertson, of New York city, lectured on "The Diaphragm Storage Battery."

MR. F. F. TAYLOR, who was local manager of the Hudson River Telephone Company, at Schenectady, N. Y., for some time past, has been promoted to the general superintendent's office, which is at the main offices of the company, Albany, N. Y. Mr. R. R. Bishop, manager of the long-distance service of the company at Troy, N. Y., will succeed Mr. Taylor at Schenectady.

MR. GEORGE F. McCULLOCH, of the Indiana Union Traction Company, no longer holds interests in Ft. Wayne and other northern Indiana traction lines, it is reported, and that the real heads of the traction interests in Ft. Wayne and vicinity are residents of Philadelphia. Mr. Henry C. Paul is resident representative of the Ft. Wayne traction line, and Mr. F. B. Fleming is secretary.

MR. S. W. WISE has resigned the position of manager of the Mississippi Valley Traction Company, which recently leased the Moline, East Moline & Watertown Railway Company. It is reported that Mr. Wise has gone to Boston, Mass., to practice his profession of electrical engineering. Before leaving Moline, Ill., the employés of the company presented him with a gold watch fob embellished with a masonic design.

MR. T. ROBERT SMITH, A. M. I. E. E., chief electrical and mechanical assistant to the borough engineer of Leicester, England, has been appointed by the tramway committee of the corporation of Leicester to be the resident electrical engineer for its electric tramways, to take charge of the working and general repairs and maintenance of the completed electrical plant and equipment of the power station, car depots, overhead work, cars and feeder system.

GENERAL EDWIN S. GREELEY has retired from the presidency of the Yale National Bank, New Haven, Ct. At the directors' meeting held last week resolutions were adopted accepting General Greeley's resignation and warmly praising his work and personal characteristics. General Greeley was a pioneer in the electrical field, organizing at the close of the Civil War a telegraphic supply house. He was an organizer of the New Haven Electric Light Company and the New Haven Car Trimmings Company. He has a splendid war record, and is now a prominent member of the Army and Navy Club, of Connecticut, and of the Sons of the American Revolution.

W. H. COVERDALE & COMPANY have recently been incorporated to do a general engineering and contracting business, with offices at 66 Broadway, New York. Their organization includes engineers of experience in all matters relating to the design and construction of steam and electric railroads, lighting and power plants, coal and ore-handling machinery. Mr. Coverdale was for many years in the engineering department of the Pennsylvania lines west of Pittsburg, and was track elevation engineer of that company in Chicago during 1898-99. He was also prominently identified with the construction of the Westinghouse shops at East Pittsburg, and for the last three years has been civil engineer for a New York firm of engineers and contractors.

COLONEL JONATHAN T. DICKINSON, vice-president of the Consolidated Railway Electric Lighting and Equipment Company, general offices, Hanover Bank Building, New York, is authority for the statement that the Consolidated company has more of its "axle light" equipments of electric car lighting in use on the best cars constituting the finest trains of leading railway lines than all other systems of electric car lighting combined. He also states that the chief mechanical officials of several of the great railway systems in the country, where a large number of "axle light" equipments have been in service for the past few years, have warmly endorsed the Consolidated "axle light" system. Each car carries its own independent electric car lighting apparatus, ready for immediate and constant use, no matter in what service the car may be placed.

ELECTRICAL SECURITIES.

The stock market showed decidedly good resisting qualities during the past week, in the face of strong bear pressure for lower values. There has been little or no heavy liquidation, and while there is little hope held out for any decided advance in values, it is highly probable that the coming months will not witness any great decline. It is now taken for granted that neither Russia nor Japan will attempt a loan for some months. This being the case, there will be but little excitement in foreign financial centres, and consequently no unsettling of bond values in the United States. Despite the foreign financial situation of the past two weeks, there has been but little unloading of securities here. The returns from large railroad corporations are now being watched with interest, as these show, with considerable accuracy, the trend of commercial conditions. The showing made by the Pennsylvania Railroad in its report recently proved that the industrial reaction was not as extensive as had been expected. Not only did it show a very profitable year of business, but it also showed a decided increase over the figures of last year, at the same time allowing for very extensive betterments.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 27.

New York:	*Closing.*
Brooklyn Rapid Transit	39⅞
Consolidated Gas	189¾
General Electric	158
Kings County Electric	183
Manhattan Elevated	141½
Metropolitan Street Railway	114¼
New York & New Jersey Telephone	137
Westinghouse Manufacturing Company	180

At the annual meeting of the Interborough Rapid Transit Company stockholders, retiring directors were reelected.

The stockholders of the Kings County Electric Light and Power Company at their annual meeting, held February 22, elected the following directors for the ensuing year: A. M. Young, W. F. Sheehan, William Berri, Edward A. Leslie, Seth L. Keeney, Hugh J. Grant, Charles Cooper, Horace C. Duval, Walter Ferguson, Bernard Gallagher, A. N. Brady, N. F. Brady and Thomas E. Murray.

Boston:	*Closing.*
American Telephone and Telegraph	120¼
Edison Electric Illuminating	230
Massachusetts Electric	72
New England Telephone	118
Western Telephone and Telegraph preferred	77

Philadelphia:	*Closing.*
Electric Company of America	7⅝
Electric Storage Battery common	52
Electric Storage Battery preferred	52
Philadelphia Electric	5¾
Union Traction	47½
United Gas Improvement	82¼

Chicago:	*Closing.*
Chicago Telephone	118
Chicago Edison Light	150
Metropolitan Elevated preferred	45
National Carbon common	27
National Carbon preferred	97
Union Traction	5⅛
Union Traction preferred	30

The annual report of the National Carbon Company for the year ending January 31, 1904, shows net earnings of $736,441, compared with $594,372 the previous year. The increase was $142,069, or about 24 per cent. The surplus, after deducting dividends, etc., amounts to $141,012, as against $22,734 for the year preceding. The assets of the company amount to $10,471,879, and its liabilities to $10,172,320, leaving a surplus of $299,559. The following have been elected directors of the company: John S. Bartlett, N. C. Cotabish, J. S. Crider, D. D. Dickey, H. E. Hackenberg, Hugh H. Hamill, Webb C. Hayes, Myron T. Herrick, James Parmelee and John P. Wilson.

South Side Elevated directors have declared the regular quarterly dividend of 1 per cent, payable March 31. Books close March 21 and reopen April 1.

ELECTRIC LIGHTING.

PARIS, KY.—The Paris Electric Light Company will shortly begin the work of rewiring the city.

DES MOINES, IOWA—A $40,000 electric light plant will be erected at the army post this summer.

GREENFIELD, ILL.—John L. Solomon has sold the electric plant here to Arthur Solomon, of Pawnee.

MONTICELLO, WIS.—A municipal lighting plant may be established here. E. L. Babler is said to be promoting the plan.

FOREST GROVE, ORE.—E. W. Haines has completed his electric light plant, and the city streets are now lighted electrically.

SHREVEPORT, LA.—F. R. Hodges has asked the council for a franchise permitting him to erect a lighting system in the city.

EAST LAKE, ALA.—The town council is considering the matter of issuing bonds for the purpose of erecting an electric light plant.

BALDWINSVILLE, N. Y.—The Seneca River Power Company announces that the new arc lights for the improved lighting system of the village will be in operation on April 1.

SALT LAKE CITY, UTAH—Elias Jones has been awarded a contract for erecting a new power-house for the Utah Light and Power Company at the mouth of American Fork cañon.

HARRISBURG, PA.—Twenty 2,000-candle-power arc lights have been placed in the Philadelphia & Reading yards at Rutherford by the Harrisburg Light, Heat and Power Company.

PHILADELPHIA, PA.—The bureau of health will shortly invite estimates for the erection of a power-house, to cost $125,000, for the new municipal hospital on the Macalester farm, in the thirty-third ward.

PITTSTON, PA.—The contract for building the Lehigh Valley's electric and steam power plant at Sayre has been awarded to James Stewart & Company, of Pittsburg. The building will be of brick and iron, 140 by 240 feet.

ETNA, CAL.—Manuel Preria, of Fort Jones, has sold his electric light plant in that village to the Siskiyou Electric Power Company. This company has a plant on Fall creek, and supplies power to Montague and Yreka.

GROTON, S. D.—The city council has granted a franchise for electric light, gas and heating plants to Herman E. Miles, of St. Paul. The conditions provide that the lighting plant shall be installed and in working order in six months.

ALBANY, N. Y.—The trustees of buildings have decided to renew the contract with the local lighting company for lighting the capitol and other state buildings. The term of the contract is two years, from January 1, 1903, to January 1, 1905.

LOS ANGELES, CAL.—The new power-house to be built by the Pacific Light and Power Company on the Mission road, near the eastern city limits, will be 98 by 81 feet, brick construction, iron truss roof, cement floor and thoroughly fireproof.

SALT LAKE CITY, UTAH—A franchise has been granted to Harry J. Allen by the city council of Bellevue, giving Mr. Allen the right to operate a light and power plant in that city for fifty years. Work must begin within three months and be completed within a year.

NILES, OHIO—The New Castle council has ordered plans and specifications for the erection of a $65,000 municipal electric light plant, according to estimates furnished by a Pittsburg firm. The total cost of operation is estimated at $21,790 annually, for 300 lights and running expenses and salaries.

RICHMOND, IND.—The Richmond Light, Heat and Power Company has filed a mortgage on its local property for $300,000, covering an issue of bonds in that sum which will be sold to meet the cost of improvements to the local plant. The mortgage is in favor of the Continental Trust Company, of New York.

SHIPPENSBURG, PA.—Arrangements are being perfected for the merging of the Shippensburg Gas Company and the Electric Light and Power Company into the Shippensburg Heat, Light and Power Company. The electric power will be generated by means of a water power two miles distant from the borough.

CHARLOTTE, N. C.—At a meeting of the board of directors of the Greensboro Electric Company, it was decided to immediately make many improvements to the electric and street car plant. A new steam turbine wheel will be installed at the power-house, the boiler capacity will be increased and improvements will be made in the rolling stock.

HAMMOND, IND.—The South Shore Gas and Electric Company has succeeded to the property and business of the Hammond Illuminating Company. It now supplies light to Hammond, and also to the manufacturing towns of East Chicago and Indian Harbor, and has laid down thirty-one miles of mains, besides practically rebuilding the Hammond property.

MALONE, N. Y.—The Malone Light and Power Company is preparing to make extensive improvements to its plant as soon as practicable, a dynamo of nearly twice the capacity of the present one being one of the changes decided upon. New water-wheels will be put in and alterations made which will enable all of the power developed by the dam and falls to be utilized.

OGDEN, IOWA—The city of Ogden, Iowa, has appointed Dow & Hadfield, Ames, Iowa, as its consulting engineers and authorized them to prepare plans and specifications for a city lighting plant. Specifications will be drawn up and bids received on the following: an electric plant of approximately 1,800 lights, a gas plant of 1,800 red lights and a combined gas and electric plant. Plans will be on file at the city recorder's office after February 26. Bids will be received up to noon of March 15.

LOS ANGELES, CAL.—The Downey Electric Light and Power Company has been granted a franchise to use certain streets and highways in and around the village of Downey for the erection of a system of lines and conduits for the transmission of electric light and power. The life of the franchise is thirty years, and work on the plant must be commenced within six months and finished in three years. After March 15, 1909, the company is to pay the county three per cent of the gross receipts.

PITTSBURG, PA.—The mayor has approved the ordinance authorizing the award of a public lighting contract for one year. The bill permits the expenditure of $400,000, but the appropriation pending in the common council is only $350,000. It is said this will likely be increased. The Allegheny County Light Company is now furnishing the light at the same rates charged under the contract that expired at the end of 1903. Bids were received for a new four-year contract, but the action of the council in ordering a contract for but one year makes necessary a new advertisement for bids.

NIAGARA FALLS, N. Y.—In their eighteenth annual report, the commissioners of the Niagara Falls Queen Victoria Park Commission state that the Canadian Niagara Power Company has prosecuted with great energy its various works with a view to the completion of the first instalment of its output within the time limit, July 1, 1904, but the commissioners recommend that the government grant the company a six months' extension of the time limit. If granted this extension the company agrees that the initial output of power on January 1, 1905, shall be 50,000 horse-power instead of 20,000, which the agreement provided should be ready by July 1, 1904. The company also agrees to complete by January the whole of the work in connection with the intakes, etc., so as to provide water connections for the development of the full amount of power authorized, namely, 100,000 horse-power.

PENDLETON, ORE.—The Washington & Oregon Power Company has filed notice of appropriation of water from the south fork of the Walla Walla river, in the Blue mountains, for the purpose of securing power for an electric plant with which it intends to furnish electricity for lighting purposes in Walla Walla, Pendleton and intermediate towns. This company is owned by the Northwest Gas and Electric Light Company, which now owns the electric plants in both Pendleton and Walla Walla, and is preparing to install plants in the intermediate towns. The capital stock is $400,000. The headgate of the pipe line is located about fourteen miles east of Weston, and will carry the water a distance of six miles and drop it over a spur of the Blue mountains, giving a fall of 200 feet. Here a reservoir and power plant will be established. Isaac W. Anderson, president of both companies, says that in time an electric railway will be built between Walla Walla and Pendleton and run by power generated from this plant in the Blue mountains. The primary cost of the piping of the water and construction of the power plant is estimated at from $250,000 to $300,000.

ELECTRIC RAILWAYS.

BALTIMORE, MD.—During the present year a trolley railway will be built connecting Middletown, Del., Warwick and Fredericktown, Md.

WASHINGTON, D. C.—Frank Gould, the owner of the street car system in Richmond, is said to be considering the matter of extending the lines to this city by way of Ashland and Fredericksburg.

MONONGAHELA, PA.—At a meeting of the directors of the Monongahela City, Ellsworth & Washington Street Railway Company it was decided to accept the franchise offered the company by the city council.

BRISTOL, VA.—Citizens of Russell County, Va., are considering a plan to construct an electric line from Cleveland to Bristol *via* Abingdon, Va. The distance is about fifty miles, and the road would, it is said, prove a great convenience.

ROCHESTER, N. Y.—At a special meeting of the Rochester Railway Company it was voted to increase the capital stock of the company $500,000, to pay for proposed extensions and betterments. The present capital of the company is $5,000,000.

INDIANAPOLIS, IND.—The Canton, Ill., council has granted an electric railway franchise of forty-nine years to the Illinois Central Electric Railway Company. U. G. Oredorff, William Hanlon, R. F. Henkle and M. W. Rafferty represented the company.

MALONE, N. Y.—Arrangements are being made to convert the New York & Ottawa Railroad into an electric road the coming summer. The line extends from Ottawa to Tupper Lake, and is about 120 miles long. Power will be secured at Ottawa, Cornwall and Massena Springs.

TUSCUMBIA, ALA.—The Sheffield company, which is building the electric street railway between Tuscumbia, Sheffield and Florence, and in addition a waterworks system and electric light plant for the three cities, is pushing the work rapidly, and hopes to have the complete system in operation in about sixty days.

SPRINGVIEW, NEB.—Steps have been taken for the organization of the proposed company to build an electric line from this city to Newport. At a meeting of interested parties it was estimated that $150,000 could be raised among the citizens of the two towns. The remaining $150,000 of the proposed $300,000 capitalization will be raised by floating bonds.

INDIANAPOLIS, IND.—G. A. Madden, of Kingman, has promoted an electric road from Covington to Rockville, which will be financed by eastern capital. The proposed route is from Covington through Coal Creek, Kingman, and into Rockville. The headquarters and power station will be in Kingman, and it is proposed to build the road this year.

TAYLORVILLE, ILL.—The directors of the American Traction Company, which will construct an interurban railway system in Christian County, have decided to increase the capital stock of the company from $200,000 to $1,000,000. The directors are John B. Colegrove, Ernest Hoover, Clyde Sattley, E. W. Vollintine, W. A. Powel, John Dacy, H. J. Magner and C. A. Rhodes.

PENN YAN, N. Y.—The surveys of the proposed electric railroad to start from Hornellsville and run to Hammondsport, thence skirting the western shore of lake Keuka, through the towns of Pultemey and Jerusalem to Branchport, there to connect with the Penn Yan, Keuka Park & Branchport Electric Railroad, have been completed. The complete road will be 46.8 miles in length, and the route is considered easy and safe.

BATAVIA, N. Y.—The Buffalo & Depew Railroad Company has filed with the county clerk the franchises which it secured from the towns of Darien, Pembroke, Batavia, Stafford and Le Roy. These acceptances and franchises give the trolley company the right of way from the edge of Erie to the southern edge of Monroe County. There is every indication that the work of building the road will be rushed at the opening of spring.

KNOXVILLE, TENN.—The Knoxville Traction Company and Knoxville Electric Light and Power Company have passed from the control of the Railway and Lights Company of America, to Ford, Bacon & Davis, of New York. C. H. Harvey, general manager of both the old companies, was elected president of the two new companies. Large improvements are promised in the way of new cars, increased power-house, trackage, etc.

FINDLAY, OHIO—The organization of the Forest, Findlay & Marion Electric Railway has been completed and the right of way over the greater part of the route secured. The road, which will operate between the cities of Forest, Findlay and Marion, will be fifty-four miles in length, and will take in the villages of Mount Blanchard, Marseilles, Scottown and Houcktown. It is expected that work will be completed within a year, the cost being estimated at $1,500,000.

HARRISBURG, ILL.—At a special meeting of the board of supervisors a franchise was granted to the Illinois & Kentucky Railroad Company, of Chicago, to locate, construct and operate an electric railroad over the highways in Saline County. The company proposes to run a line from this city to Marion, in Williamson County, another branch from this city to the Ohio river in Hardin County, and a line from Carrier Mills to Eldorado. J. T. Hanrahin and A. M. McConaughey, of Chicago, representing the railroad company, say they will begin work as soon as the frost is out of the ground.

PITTSBURG, PA.—Pittsburg capitalists, headed by J. W. Boileau and W. S. Ravenscroft, will build a new trolley line from Franklin to Butler, a distance of fifty-three miles. When the new line between Pittsburg and Butler is completed this spring, the proposed system will connect Franklin direct with Pittsburg by electric railway. A charter has been applied for and the company will be capitalized at about $400,000. The new line will run through Grove City, Slippery Rock, Sandy Lake, Stoneboro, Jackson Center, Polk, Prospect, Portersville, West Liberty and several other small towns. Application for franchises in the towns the line is proposed to run through have been made by the incorporators and some of these have been granted. When all are assured, the company will purchase the rights of way and begin at once the construction of the system.

NEW INCORPORATIONS.

EAST ST. LOUIS, ILL.—Corn Belt Traction Company. $205,000.

STONINGTON, CT.—Westerly Railway and Lighting Company. $400,000.

EGG HARBOR CITY, N. J.—The Egg Harbor City Telephone Company. $10,000.

MILWAUKEE, WIS.—Baraboo Telephone Company. Increased from $30,000 to $50,000.

SPRINGFIELD, ILL.—The Harrisonville Telephone Company. Increased from $20,000 to $30,000.

DES MOINES, IOWA—Ellsworth Mutual Telephone Company. $10,000. Incorporators: J. H. Sparboe and M. H. Brinton.

INDIANAPOLIS, IND.—Cynthianne Telephone Company. $3,000. Incorporators: G. Cannaday, W. J. Helms and G. Burke.

ALBANY, N. Y.—Kelsey Telephone Company. $2,000. Directors: G. A. Webster, J. H. Alexander and Lucius Huntington, Kelsey.

VELPEN, IND.—Velpen Home Telephone Company. $500. Incorporators: L. R. Broadwell, W. R. Relsey and G. M. Greene.

NORBORNE, MO.—Norborne Telephone Company. $15,000. Incorporators: N. P. Evans, Newlan Conkling, D. A. Mansur and others.

ALBANY, N. Y.—Launt Hollow Telephone Company. $500. Incorporators: Ralph J. Andrews, Edward Signor and J. L. Wanamacher.

JERSEY CITY, N. J.—United Light and Traction Company. $300,000. Incorporators: M. Leon Berry, Norman Grey, Wilfred B. Wolcott.

STANDBERRY, MO.—Standberry Electric Light Company. $25,000. Incorporators: James T. Norman, Alvin C. Frosbie and Thomas D. Hussey.

MOUNT PLEASANT, IOWA—Mount Pleasant Telephone Company. $5,000. Incorporators: E. B. Jones, J. M. Bennett, M. Gallagher, J. A. McGlenn and C. H. McMillen.

COLUMBUS, OHIO—The Findlay, Forest & Marion Railway Company. To construct an electric line from Findlay to Marion. Incorporators: Claude Meeker, Walter B. Beebe, Harry E. Armbruster, M. B. Earnhart and W. A. Morrison.

INDUSTRIAL ITEMS.

LINTON & SOUTHWICK, Worcester, Mass., is sending out bulletins Nos. 103, 105, 106 and catalogue "C," illustrative and descriptive of the line of switches which it manufactures. Bulletins and catalogue will be sent on request.

THE UNION ELECTRIC COMPANY, Baltimore, Md., is announcing that its plant was not injured in the recent fire, and is prepared to take contracts for wiring installations in accordance with the new city regulations.

THE CONSOLIDATED RAILWAY ELECTRIC LIGHTING AND EQUIPMENT COMPANY, New York city, N. Y., is announcing the removal of its offices to the Hanover Bank Building, Nassau and Pine streets, New York city, N. Y.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., describes in bulletin No. 81 the installation of chloride accumulators for the San Francisco, Oakland & San Jose Railway Company. Bulletin will be sent on request.

THE H. O. S. ENGINEERING COMPANY, 88 Warren street, New York city, N. Y., has sent out a leaflet in which is listed a few "H.O.S." panel-board cabinets and covers. Other sizes than those in leaflet are made to order. Leaflet will be sent on request.

THE CANCOS MANUFACTURING COMPANY, 146 North Second street, Philadelphia, Pa., is sending out a souvenir in the form of a folder containing poetry in connection with "Black Squadron" packing, which it manufactures. This folder will be sent on request.

L. SCHUTTE & COMPANY has been incorporated, and will continue business, with increased facilities, and with the same staff, at the old address, Twelfth and Thompson streets, Philadelphia, Pa., under the name of Schutte & Koerting Company, engineer and machinist.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has just issued a folder picturing and describing the "Greenwood" safety wire guard for which it is selling agent. The company claims this guard to have many features of value to the electric light man and contractor.

THE CRESCENT COMPANY, Omaha Building, Chicago, reports a gratifying increase in orders for "Crescent" soldering sticks. Notwithstanding the fact that this has been on the market but little over a year, it has already become very popular among users of soldering sticks.

THE BUFFALO FORGE COMPANY, Buffalo, N. Y., is issuing two new catalogues which it has just had printed. One illustrative and descriptive of the "Buffalo" steel-plate planing mill exhausters and the other of the "Buffalo" centrifugal pumps. These two catalogues will be sent on request.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., and 136 Liberty street, New York city, N. Y., has issued its new catalogue No. 4, dated January 1, 1904, together with discount sheet. Catalogue and discount sheet will be sent on request to those who have not already received them.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is sending out an interesting catalogue, illustrative and descriptive of "Westinghouse" auxiliary apparatus for railway equipments. The company is also issuing circular No. 1061, in which is listed and described "Westinghouse" automobile charging outfits. Catalogue and circular will be sent on request.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York city, N. Y., and Chicago, Ill., is sending out a reduced price list covering National Electric Code rubber-covered wire, "Circular Loom" or "Flexduct," "9171" receptacles, fuse plugs and incandescent lamps. It also announces that a number of new articles not listed in catalogue No. 14 are ready. Pamphlets of new articles and reduced price list will be sent on request.

FRANCIS B. CARLETON, M. D., Lauderdale Building, Providence, R. I., is supplying central stations and electrical installations in general with an emergency medical chest, for use in case of an employé becoming injured through electric shock. A number of companies have already ordered these emergency outfits, and Dr. Carleton will be pleased to communicate with any one desirous of securing complete information on this subject.

THE STANDARD TOOL COMPANY, Cleveland, Ohio, is distributing a handsome wall calendar and pad. The company is the manufacturer of reamers, taps, milling cutters and twist drills. Underneath the pad of the calendar, on the heavy back, there is printed a ready reference table of machine and hand taps, pipe taps and machine screw taps. The inverse side of the calendar back contains tables of sizes of twist drills from one-half inch to No. 80, with decimal equivalents, cutting speeds for milling cutters, cutting speeds for shaper, planer and lathe tools, dimensions of reamers for standard sockets, standard socket sizes and standard threads.

THE H. W. JOHNS-MANVILLE COMPANY, whose New York office is located at 100 William street, held a convention February 15 to 20, 1904, of the branch managers, department managers and salesmen of the company. The delegates first met in Hartford, Ct., where they were guests of the Johns-Pratt company. The object of the convention was to bring all branches of the company into closer touch with each other and to give an opportunity for a discussion of the various lines manufactured by the company. The delegates to the convention assembled at the company's New York office, Thursday, February 18, and the remainder of the programme was carried out in New York.

THE NATIONAL CONDUIT AND CABLE COMPANY, 41 Park Row, New York city, N. Y., manufacturer of bare copper wire, weatherproof and lead-covered wire and cables, is issuing an interesting leaflet entitled "Copper Gossip." This leaflet contains information as to the general business outlook, the copper market situation, London copper market, New York and London copper prices, imports of copper in 1903, and exports of copper during January, 1904. The company is also sending out a photograph of its works at Hastings-on-Hudson, N. Y., and on the back of the photograph it quotes price on three-braid weatherproof wire. Leaflet and photograph will be sent on request.

THE NERNST LAMP COMPANY has appointed Mr. G. E. Bennett to act as district sales manager of its Buffalo district office, recently established at 17 West Mohawk street. These quarters will include an office, showroom, exhibition room and stockroom, with a complete stock of lamps and supplies to meet the requirements of the trade in this territory. The company has recently closed contracts for the installation of 165 Nernst lamps in the Washington National Bank Building and seventy-five lamps for the Pittsburg Supply Company, at Pittsburg, Pa. It has also succeeded in securing the adoption of Nernst lamps by the municipal electric light plant of Silverton, Col., in competition with enclosed arc lamps.

THE LAIDLAW-DUNN-GORDON COMPANY, New York city, N. Y., announces that in pamphlet L-26-A, just issued, is described the Cincinnati air and gas compressors. These machines are of medium and small sizes, the steam ends being equipped with plain slide valves and Meyer valve gears and the air end with poppet valves. One of the compressors is of entirely new type, in that the air cylinders are provided both with mechanically moved valves and with poppet valves, all points in the compression cycle being determined by the mechanically moved valves, with the exception of the opening of the exhaust, which is determined by the poppet valves. This pamphlet, which is of convenient pocket size, will be sent on request.

THE ELECTRICAL TESTING LABORATORIES, formerly known as the Lamp Testing Bureau, have taken possession of their new quarters at 14-16 East End avenue, New York city, and are now prepared to undertake many kinds of electrical and photometrical tests. All of the apparatus formerly installed at 14 Jay street has been set up in the new laboratories, as also several new instruments which add much to their facilities. The equipment of these laboratories is most liberal and thoroughly up to date, while the technical staff consists of trained specialists and expert assistants. Tests made by the Electrical Testing Laboratories may be relied upon as being highly accurate and altogether satisfactory as to methods and thoroughness. All tests are treated with the strictest confidence, the data and reports being considered the property of the customer for whom the test is made, and are not available for the use of others. Tests are carried out with absolute impartiality, without favor to any one and with the single object of accurately determining facts as they exist for the information of him who pays for the work.